# TRANSACTIO

AND

# PROCEEDINGS

OF THE

# NEW ZEALAND INSTITUTE

1895

## VOL. XXVIII.

(ELEVENTH OF NEW SERIES)

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE

BY

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## CORRIGENDA.

Page 6, line 16. *For* Melontha *read* Melolontha.
Page 6, line 9 from bottom. *For* Leinax *read* Limax.
Page 21, line 19. *For* rostrate *read* rostrata.
Page 37, lines 1 and 9. *For* Kakaparaoa *read* Kekeparaoa.
Page 37, line 21. *After* near *insert* after some severe fighting.
Page 37, line 29. *For* tu kanapa napa *read* Tu kanapanapa.
Page 37, lines 38 and 44. *For* sister *read* daughter.
Page 37. last line. *For* Hitangua, Mahaki *read* Itanga-a-Mahaki.
Page 38, line 32. *For* Kakaparaoa *read* Kekeparaoa.
Page 39, line 9. Kahungunu was the father of Tauhei.

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# NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

## BOARD OF GOVERNORS.

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The Hon. the Colonial Secretary.

(NOMINATED.)

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(ELECTED.)

1895.—James McKerrow, F.R.A.S.; S. Percy Smith, F.R.G.S.; Major-General Schaw, C.B., R.E.

MANAGER: Sir James Hector.

HONORARY TREASURER: W. T. L. Travers, F.L.S.

SECRETARY: R. B. Gore.

# ABSTRACTS OF RULES AND STATUTES.

GAZETTED IN THE "NEW ZEALAND GAZETTE," 9TH MARCH, 1868.

SECTION I.

*Incorporation of Societies.*

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for

which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £50.

3. The by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of the annual revenue in or towards the formation or support of some local public museum or library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and library of the New Zealand Institute.

4. Any society incorporated as aforesaid, which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and may then be published as Proceedings or Transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:—

*Regulations regarding Publications.*

(*a.*) The publications of the Institute shall consist of a current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute," and of transactions, comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), to be intituled "Transactions of the New Zealand Institute."

(*b.*) The Institute shall have power to reject any papers read before any of the incorporated societies.

(*c.*) Papers so rejected will be returned to the society in which they were read.

(*d.*) A proportional contribution may be required from each society towards the cost of publishing the Proceedings and Transactions of the Institute.

(*e.*) Each incorporated society will be entitled to receive a *proportional* number of copies of the Proceedings and Transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f.*) Extra copies will be issued to any of the members of incorporated societies at the cost-price of publication.

6. All property accumulated by or with funds derived from incorporated societies, and placed in charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the by-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the society.

### Section II.

*For the Management of the Property of the Institute.*

9. All donations by societies, public departments, or private individuals to the Museum of the Institute shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal, to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to natural science may be deposited in the library of the Institute, subject to the following conditions:—

(*a*.) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b*.) Any funds especially expended on binding and preserving such deposited books at the request of the depositor shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c*.) No books deposited in the library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and library, subject to by-laws to be framed by the Board.

### Section III.

The laboratory shall for the time being be and remain under the exclusive management of the Manager of the Institute.

### Section IV.

(Of Date 23rd September, 1870.)

*Honorary Members.*

Whereas the rules of the societies incorporated under the New Zealand Institute Act provide for the election of honorary members of such societies, but inasmuch as such honorary members would not thereby become members of the New Zealand Institute, and whereas it is expedient to make provision for the election of honorary members of the New Zealand Institute, it is hereby declared,—

1. Each incorporated society may, in the month of November next, nominate for election, as honorary members of the New Zealand Institute, three persons, and in the month of November in each succeeding year one person, not residing in the colony.
2. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.
3. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be honorary members of the New Zealand Institute, provided that the total number of honorary members shall not exceed thirty.

## LIST OF INCORPORATED SOCIETIES.

| NAME OF SOCIETY. | DATE OF INCORPORATION. |
|---|---|
| Wellington Philosophical Society - | 10th June, 1868. |
| Auckland Institute - - - - - | 10th June, 1868. |
| Philosophical Institute of Canterbury | 22nd Oct., 1868. |
| Otago Institute - - - - - - | 18th Oct., 1869. |
| Westland Institute - - - - - | 21st Dec., 1874. |
| Hawke's Bay Philosophical Institute - | 31st Mar., 1875. |
| Southland Institute - - - - - | 21st July, 1880. |
| Nelson Philosophical Society - - | 20th Dec., 1883. |

## OFFICERS OF INCORPORATED SOCIETIES, AND EXTRACTS FROM THE RULES.

### WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1896.—*President*—W. T. L. Travers, F.L.S.; *Vice-presidents*—R. C. Harding, Sir James Hector, F.R.S.; *Council*—Edward Tregear, F.R.G.S., Major-General Schaw, C.B., R.E., Sir W. L. Buller, F.R.S., H. Farquhar, W. M. Maskell, G. V. Hudson, F.E.S., Thomas Kirk, F.L.S.; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

*Extracts from the Rules of the Wellington Philosophical Society.*

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of members of the Society shall be fixed by the Council, and duly announced by the Secretary.

### AUCKLAND INSTITUTE.

Office-bearers for 1896.—*President*—D. Petrie, M.A., F.L.S., *Vice-presidents*—Professor A. P. Thomas, F.L.S., J. H. Upton; *Council*—G. Aickin, J. Batger, W. Berry, Professor F. D. Brown, F.C.S., C. Cooper, E. A. Mackechnie,

T. Peacock, J. A. Pond, F.C.S., Rev. A. G. Purchas, M.R.C.S. Eng., T. H. Smith, J. Stewart, C.E.; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Curator*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

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*Extracts from the Rules of the Auckland Institute.*

1. Any person desiring to become a member of the Institute shall be proposed in writing by two members, and shall be balloted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance-fee, in addition to the annual subscription of one guinea, the annual subscription being payable in advance on the first day of April for the then current year.

5. Members may at any time become life-members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual general meeting of the society on the third Monday of February in each year. Ordinary business meetings are called by the Council from time to time.

## PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1896.—*President*—Professor Arthur Dendy, D.Sc.; *Vice-presidents*—Dr. W. Thomas, Dr. W. P. Evans; *Hon. Secretary*—R. Speight; *Hon. Treasurer*—Captain F. W. Hutton, F.R.S.; *Council*—H. R. Webb, R. M. Laing, S. Page, P. Marshall, F. C. Binns, and Dr. W. H. Symes.

*Extracts from the Rules of the Philosophical Institute of Canterbury.*

8. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the 1st November in each year.

The Institute may also admit associates, who shall contribute five shillings annually to the funds of the Institute, and shall have all the privileges of members, except that they shall not have the power to vote, or be entitled to the annual volume of the Transactions.

9. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

15. The ordinary meetings of the Institute shall be held on the first Wednesday in each month during the months of May to October, both inclusive.

## OTAGO INSTITUTE.

Office-bearers for 1896.—*President*—A. Hamilton; *Vice-presidents*—G. M. Thomson, F.L.S., J. S. Tennant, B.Sc.; *Hon. Secretary*—Professor Parker, F.R.S.; *Hon. Treasurer*—J. R. Don, M.A.; *Other Members of Council*—F. R. Chapman, T. M. Hocken, F.L.S., A. Bathgate, E. Melland, Professor Scott, M.D., A. Wilson, M.A., J. McLeod; *Hon. Auditor*—D. Brent, M.A.

*Extracts from the Constitution and Rules of the Otago Institute.*

2. Any person desiring to join the society may be elected by ballot, on being proposed in writing at any meeting of the Council or society by two members, and on payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life-members by one payment of ten pounds and ten shillings in lieu of future annual subscriptions.

8. An annual general meeting of the members of the society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

## WESTLAND INSTITUTE.

Office-bearers for 1896. — *President* — A. H. King; *Vice-president* — D. Macfarlane; *Hon. Treasurer* — T. O. W. Croft; *Trustees* — J. Chesney, A. Mahan, D. Barron, H. L. Michel, J. Churches, A. E. Cresswell, W. L. Fowler, T. H. Gill, A. J. Morton, R. W. Wade, Dr. Macandrew, and Dr. Kendall.

*Extracts from the Rules of the Westland Institute.*

3. The Institute shall consist (1) of life-members—*i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards, or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting; (2) of members who pay two pounds two shillings each year; (3) of members paying smaller sums, not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

## HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1896.—*President*—Rev. W. Colenso, F.R.S., F.L.S., &c.; *Vice-president* — T. C. Moore, M.D.; *Council*—J. W. Craig, H. Hill, B.A., F.G.S., T. Humphries, J. S. Large, Dr. Milne-Thomson, T. Whitelaw; *Hon. Secretary*—W. Dinwiddie; *Hon. Treasurer*—G. White; *Auditor*—J. Crerar.

*Extracts from the Rules of the Hawke's Bay Philosophical Institute.*

3. The annual subscription for each member shall be one guinea, payable in advance on the first day of January in every year.

4. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke's Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

## SOUTHLAND INSTITUTE.

Office-bearers. — *Trustees* — Ven. Archdeacon Stocker, Rev. John Ferguson, Dr. James Galbraith.

## NELSON PHILOSOPHICAL SOCIETY.

Office-bearers for 1896. — *President* — The Bishop of Nelson; *Vice-presidents* — A. S. Atkinson, F.L.S., and Dr. W. J. Mackie; *Council* — Dr. L. Boor, Messrs. E. Lukins, W. F. Worley, J. G. Bartell, and J. Holloway; *Hon. Secretary* — R. I. Kingsley; *Treasurer* — Dr. J. Hudson; *Curator* — R. I. Kingsley; *Assistant Curator* — E. Lukins.

*Extracts from the Rules of the Nelson Philosophical Society.*

4. Members shall be elected by ballot.

6. The annual subscription shall be one guinea.

7. The sum of ten guineas may be paid in composition of the annual subscription.

16. Meetings shall be held on the second Monday in every month.

23. The papers read before the Society shall be immediately delivered to the Secretary.

# TRANSACTIONS

# TRANSACTIONS

OF THE

# NEW ZEALAND INSTITUTE, 1895.

## I.—MISCELLANEOUS.

### Art. I.—*The Displacement of Species in New Zealand.*

By T. Kirk, F.L.S.

[*Presidential Address to the Wellington Philosophical Society, 3rd July, 1895.*]

In the absence of civilisation, the indigenous fauna and flora of any country is liable to little or no change from external causes. Aërial and marine currents may occasionally bring spores or even seeds of exotic plants; more rarely, insects or birds may be introduced by gales of unusual violence; migratory or aquatic birds may introduce the eggs of insects, or even molluscs, as well as seeds and fragments of terrestrial or lacustrine plants, which have become attached to their feathers; and certain terrestrial or fluviatile molluscs may be introduced by drifted logs; but after a certain time any increase in the number of species by agencies of this kind must become extremely rare, and can occur only at distant intervals. It may therefore be concluded that in all probability the constituents of the fauna and flora of this colony, with possibly the exception of the larger Ratite birds, were in much the same condition when they were first seen by Cook and Vancouver as they had been for many previous centuries. But with the advent of civilisation vast and far-reaching changes speedily take place: axe and fire rapidly alter the face of the country; portions of the forest are felled, burnt off, and replaced by grass—a change which of itself involves a multitude of other changes; the unfelled portions of the forest are laid open to violent winds, so that the surface-rooting trees are blown over in large numbers, while the increasing dryness of the atmosphere acts unfavourably

on the undergrowth, which is still further injured by the depredations of cattle; gradually the plants less able to resist changed conditions disappear, and with them many insects, lizards, and birds, which are unable to obtain their usual food in the new environment.

But the space occupied by the displaced plants is not long allowed to remain unoccupied. An army of encroaching weeds speedily takes possession of the vacancy: thistles, star-thistles, docks, groundsels, brambles, briars, and a hundred other unattractive invaders make their appearance, and increase the severity of the struggle for the survivors of the indigenous flora. From sea-level to the highest points reached by the miner or shepherd, from the North Cape to the Antarctic Islands, their hosts press forward, ever seizing some new position, just as on a larger scale they have long since occupied the vicinity of the chief ports on the great lines of ocean travel from Britain to the Cape of Good Hope, from Yokohama to Cape Horn, so that wherever the traveller lands from his floating home he finds himself surrounded by familiar plants which have in a greater or lesser degree amalgamated with the vegetation of the country which they have invaded, and which to a large extent they will ultimately overcome.

And, most unhappily, this invasion is not restricted to phanerogamic plants. Numbers of injurious fungi accompany their hosts. Rust, mildew, and bunt blight the hopes of the wheat-grower at the moment of fruition. The grazier too often sees his pastures rendered useless by the ravages of smut and ergot; while the cultivators of edible fruits and vegetables can point to special enemies of almost every kind of plant grown for its value as an article of food. Nor is this all. Numbers of species, almost equally insidious in their development, are parasitic, not only on members of the indigenous flora, but on the naturalised weeds themselves; so that the circle of infection is constantly widening, while the scientific knowledge and practical skill of the cultivator are taxed to the utmost limit.

Further, the invading army of plants has brought in its train a still more dangerous host of animals; and as in the vegetable kingdom the most injurious forms were found amongst the less highly organized kinds, so in the animal kingdom the invaders whose agency is most dreaded are members of the Invertebrata: the mussel scale, the fluted scale, the black scale, and many others, together with numerous species of plant-lice, will occur to you as belonging to lowly-developed forms of Insecta. Higher in the scale, the Hessian fly, wire-worm, turnip-fly, and others; while numerous species of earth-worms, molluscs, birds,

and even mammals, whether introduced purposely or accidentally, affect alike both fauna and flora.

### NATURALISATION, DISPLACEMENT, ETC.

It may be advisable to remind you that a plant or animal is said to be naturalised in a new country when it has become so thoroughly established as to be able to perpetuate itself spontaneously. The term, however, must not be confused with acclimatised, which, as popularly used, conveys the erroneous idea that the organization to which it is applied has been specially adapted to its new environment by having passed through a series of changes. What is called "acclimatisation" is based on the simple fact that many plants and animals are able to flourish under conditions differing from those under which they were originally placed.

Displacement, although usually attended by a diminution in the number of individuals, is sometimes accompanied by increase, as is the case with those insects which now obtain a large supply of food from introduced plants, and consequently exhibit a vast increase in numbers. Replacement can only be said to occur when the naturalised organism occupies the position of that which it has displaced; the displacement being approximately, although perhaps not actually, complete. On the other hand, complete displacement is not always followed by immediate replacement. The tuatara (*Sphenodon punctatum*), for instance, has been all but destroyed on the mainland by the wild pig and the cat, but these cannot be said to have taken the place of the tuatara—their agency has been wholly destructive. On the other hand, the place formerly occupied by the Maori rat in the North Island is now so fully occupied by its old enemy the black rat as to afford a striking instance of complete replacement. It will be useful to bear these distinctions in mind when considering the influence exerted by introduced organisms on the flora and fauna of any country.

It is not proposed to consider in detail the effects produced by naturalised organisms on the flora and fauna of the colony, but merely to draw attention to various cases, more or less of a typical character, and to state the general results so far as they have been ascertained.

### INVERTEBRATA.

Although there is some probability that certain species of Infusoria, Rotifera, and possibly Hydrozoa have been introduced into the colony, there is no direct evidence to that effect; while so little is known respecting either native or introduced Entozoa, beyond the fact that several species have made their appearance here as uninvited guests, that atten-

tion may at once be directed to the earth-worms, of which several European species have become naturalised, and succeeded in replacing indigenous forms in various localities in both Islands. When recently travelling in the upper portions of the valleys of the Rangitikei and Turakina I found that in localities where a few years back native worms were plentiful the introduced *Lumbricus terrestris* (L.) had spread over large areas of grass-land to such an extent that it was impossible to find a single square foot of earth free from its castings, while in many places its burrows rendered the soil so spongy that it was dangerous to the passing horseman. As a rule, native worms are most frequent in unploughed land; a single ploughing destroys large numbers, and if the land is frequently ploughed the native kinds speedily disappear—a result invariably accelerated by the advent of introduced species, which quickly effect a complete replacement. It is stated that a large worm which, in the Kaipara, frequently attained a length of over 20in., and was used as food by the Maoris, has not been seen of late years: I believe it has not been described.

Amongst Arachnida the small introduced mite known as the red spider (*Tetranychus telarius*) has increased enormously in some districts, and is found on native and introduced shrubs alike; but my knowledge of the indigenous species of this group is not sufficient to enable me to state whether actual displacement may be observed or not. Many spiders of kinds usually found in or about dwelling-houses in Europe have been accidentally introduced, but it is not clear that they have succeeded in replacing indigenous species.

When the limited area to which many of our indigenous insects are restricted is considered in connection with the wide area over which clearing operations have extended, it will be difficult to evade the conclusion that many species, and possibly entire genera, have become extinct, their places being now occupied by introduced species, although under different conditions; but this can hardly be considered true replacement, and, so far as known to me, no instance has been observed of an introduced insect having extirpated an indigenous species, although not a few of the latter have become rare in districts where they were formerly plentiful, and in all probability the food-supply of others has been reduced by the agency of the honey-bee.

Amongst the indigenous insects which are now to be met with only in diminished numbers is the elephant beetle (*Lasiorhynchus barbicornis*, Fabr.), which was formerly plentiful in the vicinity of Wellington, as in other districts, but is now comparatively rare. Its high degree of specialisation invests it with exceptional interest, so that its diminution can only be witnessed with regret.

Amongst introduced insects are numerous Coccidæ, of which there are upwards of twenty species, many of them being highly injurious, the three most dangerous perhaps being the fluted scale (*Icerya purchasi*, Mask.), which affects many species of indigenous and cultivated trees and shrubs; the mussel scale (*Mytilaspis pomorum*, Bouché), the great pest of the apple, but also found on numerous shrubs and trees, both introduced and indigenous; and the black scale (*Lecanium oleæ*, Bern.), all of which are widely dispersed, and may be found intermixed with the indigenous *Dactylopius glaucus* (Mask.), and other native forms, which have increased to a large extent owing to the large supply of introduced plants available for food, and possibly to the absence of enemies. In the case of the *Dactylopius*, at least, this increase is occasionally accompanied by a partial abandonment of the native plants on which it formerly subsisted. There does not appear to be any instance of the replacement of a native scale-insect by an introduced species. The number of naturalised aphidian insects is even larger than that of the Coccidæ; but, unlike the members of that group, they do not come into competition with indigenous species, as the family can scarcely be said to be represented in the indigenous fauna, a single undescribed species of doubtful affinity being the only form observed at present; it is small, apparently rare, and seems restricted in its choice of food to a purely herbaceous groundsel (*Erechtites prenanthoides*, DC.). The introduced kinds, however, have increased to a vast extent, and in many instances infest different kinds of plants to those on which they usually live in Europe. Amongst the most troublesome are *Aphis pruni* (Réaum), on the plum; *A. amygdali* (Fonsc.), on the peach; *A. mali* (Fabr.), chiefly on pome fruits; *Siphonophora fragariæ* (Koch), on the strawberry; and *Schizoneura lanigera* (Hans.), on pome fruits: all of which are widely distributed; while *Phylloxera vastatrix* (Planch.) is only found in the north.

Thrips appear to be in course of displacement by introduced species, but my knowledge of this group is insufficient to allow of details being given on this occasion.

Few New Zealand residents of the present day can form any accurate idea of the injury and annoyance inflicted upon the early settlers by the native flesh-fly, which was formerly most abundant in all districts. A spade or other implement used by a man with greasy hands would speedily become fly-blown. Newly-cooked fresh meat could scarcely be transferred from the camp-oven to the table before it was attacked, while blankets or woollen garments were speedily rendered useless when exposed. But this troublesome pest has practically disappeared, having been displaced by the introduced

house-fly (*Musca domestica*, L.). The early settlers recognised the beneficial agency of the intruder, and carried it from the ports to the interior in paper cages.

In many districts the common mosquito, the sand-fly, and the small native flea have disappeared under the beneficial results arising from drainage and other improvements of a similar character.

Amongst indigenous insects which have increased to a large extent owing to the more copious supply of suitable food afforded by introduced plants, whether naturalised or cultivated, three species of Coleoptera deserve special mention. The grass-grub (*Odontria zealandica*, White) in the larval state is terribly destructive to the roots of grass, and has increased to a marvellous extent with the progress of settlement. The grub takes the place occupied by the cockchafer (*Melontha vulgaris*, Steph.) in Europe, but the perfect insect is less destructive, although occasionally injurious to fruit-trees. (In all probability *O. brunneum*, Broun, is equally dangerous.) A small beetle (*Colaspis puncticollis*, Broun), now occurs in vast numbers, the perfect insect feeding upon pome fruits, and doing much damage. The native borer (*Æmona hirta*, Fabr.) is another destructive insect unhappily now occurring in vast numbers. In its larval state it bores galleries in the trunk of *Olearia solandri* (Hook. f.), *Cassinia retorta* (A. Cunn.), and effects a comparatively small amount of injury; but when citrads or other fruit-trees are attacked the galleries are more numerous and more extensive. In some localities it has forsaken the Cassinia, &c., and evinces a marked preference for the lemon, orange, and lime.

Amongst introduced Mollusca must be enumerated the common snail (*Helix aspersa*, Müller), which, from its depredations in the garden and field, has become a pest throughout the colony. It is generally agreed that several of the smaller native Helicidæ have become rare since this shell was first observed in Auckland, about 1868; but there is no direct evidence to show that their diminution has been caused by their larger and more robust congener, although in some cases their food-supply must have been diminished by its ravages. The common garden-slug (*Leinax agrestis*, L.) and the large brown slug (*Arion hortensis*, L.) are generally naturalised also, but are not nearly so destructive as the *Helix*. *Limnæa stagnalis* (L.) is abundantly naturalised in the Avon at Christchurch, and may have some connection with the comparative infrequency of the smaller native molluscs in that river.

## Fishes.

There is no evidence to show that the few native freshwater fishes have suffered from the introduction of the Prussian

carp (*Carassias vulgaris*, Nord.), the trout (*Salmo fario*, L.), or from other fluviatile species; but in some localities eels have increased largely from the increased food-supply afforded by the trout-fry. In other localities, especially in deep water, the trout have suffered severely from the attacks of the fly fungus (*Saprolegnia ferox*, Kutz.), but there is no evidence to show that native fishes have been attacked by the same scourge.

### Amphibia and Reptilia.

Very few of the Amphibia and Reptilia have been introduced. A green frog from Australia (*Hyla peronii*) has become naturalised in many parts of the North Island, and shows a great liking for the young of the smaller native lizards, which, after considerable effort, are swallowed entire. It may be worth while to mention that some years ago I was shown several specimens of the water-newt (*Triton cristatus*, L.), said to have been found at the Bay of Islands. It would be interesting to learn by what agency it was introduced, and whether it still survives in that locality.

Snakes have been introduced into several localities either by accident or design, but, so far, no species has become naturalised.

The most serious loss amongst the indigenous Reptilia is the tuatara (*Sphenodon punctatum*, Gunth.), which has been all but extirpated on the mainland, chiefly by the agency of the wild pig, the cat, and probably the grey rat. It is still to be found in some quantity on several of the outlying islands. The gecko (*Naultinus pacificus*) has of necessity decreased with the destruction of forests, although it is still to be found in diminished numbers as far south as the South Cape Island, which is, I believe, the extreme southern limit of Reptilia. Several of the smaller species have become comparatively rare from the repeated burnings of the taramea and other surface vegetation, which afforded shelter alike to the lizards and the insects and Mollusca, forming their principal food.

### Birds.

Birds have suffered more severely than any other section of the fauna from the ravages of introduced mammals, in addition to which the burning of the surface vegetation has deprived many species of food and shelter, while in other cases the food-supply has been reduced by insects. Doubtless a large proportion of the species that have suffered most severely are forms that had lost much of their original vigour and were gradually dying out; yet it is most unfortunate that birds of such exceptional interest as the kakapo and kiwi should have their extinction accelerated by the introduction

of such pests as the stoat, weasel, and ferret, which are annihilating the surviving portions of one of the most remarkable collections of indigenous birds in the world.

The kakapo (*Stringops habroptilus*, Gray) has suffered so severely from introduced agencies that it is now on the verge of extinction in many districts where it was formerly found in comparatively large numbers. Its eggs, being merely laid in holes at the base of trees, have been attacked by rats, the young birds by wild cats, and the old birds by dogs, stoats, weasels, and by pigs. It still lingers in the centre of the North Island, and is found in larger quantity on some parts of the west coast of the South Island, but its extirpation throughout the colony at a near date seems absolutely certain.

It is not in all cases an easy matter to determine whether a given species has suffered more extensively from competition with naturalised forms or from the direct changes in environment effected by man himself. The destruction of the forest over wide areas at once deprives many organisms of both shelter and food, as in the case of the kaka (*Nestor meridionalis*, Gml.), which was formerly abundant where it is now rarely or never seen, a fact all the more to be regretted from its feeding largely upon insects. The kea (*Nestor notabilis*, Gould) has suffered but little from this cause, but numbers have been purposely destroyed on account of the ravages effected by them amongst sheep; still, in the high mountain districts inhabited by this bird it cannot be considered either rare or local. The parrakeets (*Platycercus novæ-zealandiæ*, Sparrm, and *P. auriceps*, Kuhl) occurred in large flocks, and were very destructive to the grain-crops of the early settlers; but under the combined attacks of rats, wild cats, and especially of man, they have become comparatively rare and local. One of the most interesting birds in the colony, the huia (*Heteralocha acutirostris*, Gould), restricted to the Ruahine and Tararua Ranges and their offshoots, partly, without doubt, from the ravages of cats, but especially from the more merciless attacks of collectors, has become extremely rare. Formerly a pair or two could usually be found at the back of the Wainuiomata without any great difficulty, but they seem to have disappeared from that locality. The migratory birds, the long-tailed cuckoo (*Eudynamis taitensis*, Sparrm) and the bronze-winged cuckoo (*Chrysococcyx lucidus*, Gml.), are becoming increasingly rare, but without any obvious cause, except possibly the decrease of *Gerygone flaviventris* (Gray), in whose nest both parasites usually deposit their eggs. It is worth while to remark that both the cuckoos may occasionally be seen all through the winter seasons. The silver-eye (*Zosterops lateralis*, Lath.), although still to be seen in large numbers in nearly all parts of the colony, is less plentiful in many districts than formerly,

but the balance of evidence seems to point to its having been introduced from Australia by natural agencies.

The tui (*Prosthemadera novæ-zealandiæ*, Gml.), the bell-bird (*Anthornis melanura*, Sparrm), and the stitch-bird (*Pogonornis cincta*, Dubus) appear to have alike suffered from the diminution of their food-supply caused by the introduction of the honey-bee, while they have been incessantly attacked by cats and rats; the tui, however, shows the greatest power of resistance, as it is still to be found throughout the colony, although in greatly diminished numbers. The bell-bird, which formerly existed in large numbers in both the North and South Islands, has become extremely rare and local in the North, although more plentiful in the South; while the stitch-bird appears to have been driven to its last refuge in the Little Barrier Island, where it still forms the prey of the destructive collector. It has been suggested that one cause of the disappearance of the bell-bird from the North Island is the diminution of its food-supply caused by the honey-bee, which is plentiful in nearly all districts; but this would render it difficult to account for its preservation in the South Island, where bees are equally plentiful. It may possibly be found that the increase of bees has been injurious to certain indigenous insects, but at present there is no evidence to that effect.

The little bush-wren (*Xenicus longipes*, Gml.) is almost extirpated in localities where it was once plentiful, and the North Island robin (*Petroica longipes*, Less.) is rarely to be seen even in sparsely-settled districts; while the little fern-bird (*Sphenæacus punctatus*, Quoy and Gaim) has become comparatively rare in numerous swamps and reed-beds where it was once common. The ground-lark (*Anthus novæ-zealandiæ*, Gml.) maintains its ground in country districts, although it has become rare in the vicinity of towns, partly, perhaps, from its being attacked by cats and rats, or by boys still more merciless. So also the familiar forest-bird the fantail (*Rhipidura flabellifera*, Gml.), although its numbers have been greatly reduced in nearly all localities. All, or nearly all, the small native birds suffer alike from the attacks of rats and wild cats. The saddle-back (*Creadion carunculatus*, Gml.) has become very rare throughout the limited portion of the North Island to which it was naturally restricted, and is now in danger of extermination on the Little Barrier Island, where it was formerly plentiful. It is almost superfluous to mention the increasing scarcity of the beautiful native pigeon (*Carpophaga novæ-zealandiæ*, Gml.). Notwithstanding its former abundance throughout the colony, there is scarcely a single district in which it is to be found in large numbers at the present time. Although it has not escaped

the ravages of rats and wild cats, the injury effected by these agencies is but trivial when compared with the destruction wrought by settlers, who have shot it during all seasons, on account of its value for food. The native quail (*Coturnix novæ-zealandiæ*, Quoy and Gaim.), once common over large portions of the colony, is practically extinct; so far as I am aware, not a single specimen has been seen for some years past, although it is believed to survive in the district between Lake Wakatipu and the Cosmos Peaks. Birds of this class suffer perhaps from the progress of settlement more severely than any others; their food is diminished, and numbers are destroyed by the surface-burnings so frequent in the early stages of a pastoral district, while they are attacked by birds of prey, cats, rats, and dogs whenever they venture into the open, and their eggs are destroyed by the weka.

The great diminution in the numbers of the northern and southern wekas (*Ocydromus earli*, Gray, and *O. australis*, Sparrm) affords strong testimony to the intensity of the struggle for existence. Both formerly occurred in great abundance, both are hardy birds, and both are extremely wary; but under the changed conditions produced by the introduction of the sheep and rabbit the wekas have greatly diminished in numbers, and are now but seldom seen near settlements. The southern weka is more plentiful in mountain districts than the northern, but it has become more wary. Although both suffered to some extent from the attacks of rats, wild cats, and dogs, no appreciable diminution was observed until the introduction of stoats and ferrets, against which they are clearly unable to contend. The striped rail (*Rallus philippensis*, L.) does not seem to have diminished so largely as might have been expected, but owing to the excessively shy habits of this bird it is not easy to form an opinion. Hutton's rail (*Cabalus modestus*, Hutt.), of the Chatham Islands, one of the most remarkable, as it is one of the rarest, of ocydromine birds, is on the verge of extinction, if it be not already extinct. It has only been found on the Islet of Mangare, which, according to a valued correspondent, is now under settlement, the first act of the settler having been to capture all the specimens of the *Cabalus* that he could find, in order to realise their market-value. It is a lamentable oversight that this small islet, the value of which could have been but trivial, was not purchased long ago in order to insure the preservation of this singularly interesting bird.

The swamp-hen (*Porphyrio melanotus*, Temm.) seemed for a time to increase with the progress of settlement rather than to diminish, but of late years there has been a marked diminution of its numbers, which may possibly be traced to the destruction of its eggs by the ubiquitous rat.

The small snipe (*Gallinago pusilla*, Buller) has become extemely rare in the few habitats where it has been observed, in all probability from its eggs having been destroyed by rats. Mr. James Baker informed me that in the early days of Auckland he had observed from twelve to twenty together on the shores of the Hauraki Gulf, but I believe it has not been observed in that locality since 1868.

The white heron (*Ardea alba*, L.) has long been known to be extremely rare in the colony, but of late years it has almost disappeared, chiefly, it may be, from the rapacity of collectors, although it has doubtless suffered from the attacks of the large hawk, and from rats, &c. The blue heron (*Ardea sacra*, Gml.) appears to have suffered but little in comparison with its white relative, as there are but few suitable places on our coasts where one or two pairs may not be seen by a patient watcher. Of late years extensive inroads have been made amongst the Anatidæ, all of which are greatly diminished in numbers. About fifteen years ago the paradise-duck (*Casarca variegata*, Gml.) was very common on the east coast of the Wellington District, between Cape Palliser and Castlepoint, but at the present time the traveller may ride the entire distance without seeing a specimen. The eggs and young birds have suffered from the attacks of rats and wild cats, while stoats and weasels are said to have disposed of the adults, and numbers have been shot for mere sport. The same diminution of numbers has been observed in the South Island, where it was always more plentiful than in the North. The brown duck (*Anas chlorotis*, Gray), the grey duck (*A. superciliosa*, Gml.) the little teal (*Querquedula gibberifrons*, Müller), and the black teal (*Fuligula novæ-zealandiæ*, Gml.), have been specially sought by the sportsman, with the result that where large numbers were formerly seen only a comparatively few individuals can be found to-day. They have also suffered severely from the depredations of rats.

Speaking generally, the oceanic birds that breed on the coasts of New Zealand appear to have suffered but little from introduced enemies, their breeding-places being usually out of reach of rats or wild cats. Captain Fairchild, of the Government steamer "Hinemoa," is of opinion that the albatros and its allies are less numerous on the Auckland and Campbell Islands than formerly, but the diminution can only have been caused by the ravages of the collector. The feet of the larger kinds are in demand for tobacco-pouches, and the head is mounted for ornamental purposes. Some years ago the late Mr. Charles Traill informed me that large numbers had been killed on the Antarctic Islands for the sake of the wing-bones, which were in demand for pipe-

stems. But nearly all the Procellaridæ, the Laridæ, and the Pelicanidæ are still to be found in vast numbers. In 1891 I visited the Snares, and was filled with amazement at the number of petrels that made their appearance on the approach of evening. From the surface of the sea to the greatest height at which it was possible to distinguish them they were to be seen in myriads, and gave me such an idea of their vast numbers as I had never before been able to realise; while their rapid but graceful evolutions were a never-ending source of pleasure. The scene reminded one of the countless vistas of stars opened to the eye of the observer through a good telescope, or, perhaps better still, of the ever advancing and receding hosts of bacteria to be seen in infusions under a high power of the microscope. The vast assemblage of penguins to be seen on the Bounty Islands did not impress me with nearly such overwhelming ideas of the numbers of marine birds as that memorable aërial scene at the Snares.

The common shag (*Phalacrocorax varius*, Gml.), which was formerly frequent on the banks of fresh-water, and more rarely of tidal, rivers, has certainly diminished of late years, although there is no danger of its immediate extinction; but, on the whole, there seems very little, if any, diminution in the numbers of the marine cormorants.

Passing from the sea-birds to the Apterygidæ, a widely different state of affairs is found to prevail. *Apteryx mantelli* (Bartl.) of the North Island is in much the same position as *A. australis* (Shaw) and *A. oweni* (Gould) of the South Island (but also found sparingly in the North). All alike are extinct, or nearly extinct, over large districts in which they were formerly so plentiful that explorers and surveyors calculated on their furnishing a considerable portion of the food-supply; but this is now entirely out of the question, and every year brings the date of their complete extinction appreciably closer. Their supply of food is indirectly reduced by the rabbits, which in some cases have invaded their haunts; their eggs are destroyed by wekas and rats; and the adult birds are killed wholesale by stoats, weasels, wild cats, and occasionally by dogs which have escaped from domestication. The complete extinction of these interesting birds by agencies now in operation will not extend over a lengthened period.

It is not easy to determine the effects produced by introduced birds upon the indigenous birds of the colony, nor in all cases to trace the lines along which their influence has been exerted; but it is advisable to make brief mention of the kinds that have become most extensively naturalised. The Chinese pheasant (*Phasianus torquatus*, Gml.) is abundant in many districts, and by its superior vigour has almost completely

absorbed the common pheasant (*P. colchicus*, L.), which was introduced at an earlier date, and has added considerably to the food-supply of the colony, but, except possibly by diminishing the food of certain indigenous species, does not appear to have exercised any injurious influence. The partridge (*Perdix cinerea*, Briss.), the Tasmanian quail (*Coturnix australis*, Lath.), and the Australian quail (*C. pectoralis*, Gould), although liberated in large numbers, have not become generally naturalised, chiefly owing to the ravages of rats and wild cats. The beautiful Californian quail (*Ortyx californica*, Steph.) has become plentiful, especially in thinly-wooded districts. The white swan (*Cygnus olor*, Gml.) has been liberated in several localities, and increased rapidly until the rats and Maoris discovered that its eggs and young birds were good for food, when a speedy diminution took place, so that at present its numbers are but small. The black swan (*C. atratus*, Lath.) is abundantly naturalised in many localities from the North Cape to Canterbury, and sometimes occurs in thousands, as in the great lagoon at the entrance to the Opawa River, where it seems to have displaced *Porphyrio melanotus*. Its simultaneous appearance in so many localities between 1865 and 1868 proves that it must have been a spontaneous immigrant, and that its naturalisation is not due in any large degree to its having been introduced by man.

The self-assertive sparrow (*Passer domesticus*, L.) is perhaps more abundantly naturalised from the North Cape to Stewart Island than any other bird, and, although it steals the grain of the farmer and the fruit of the orchardist without scruple, makes some return by the destruction of hosts of the cultivator's enemies, especially during the breeding season; but, occurring in such vast numbers, it must have trenched upon the food-supply of the smaller indigenous birds, in which it has been assisted by the yellowhammer (*Emberiza citrinella*, L.), the skylark (*Alauda arvensis*, L.), the hedge-sparrow (*Accentor modularius*, L.), the grey linnet (*Fringilla cannabina*, L.), the green linnet (*F. chloris*, L.), the chaffinch (*F. cœlebs*, L.), the goldfinch (*F. carduelis*, L.), and especially by the starling (*Sternus vulgaris*, L.), which occurs in immense flocks in nearly all districts. The Australian mainah (*Myzantha garrula*, Vig. et Hors.), with the thrush (*Turdus musicus*, L.) and the blackbird (*T. merula*, L.), in all probability have been less injurious. I am not aware of any other birds that have become so generally naturalised as to require mention here.

## Mammalia.

The indigenous terrestrial mammals are restricted to two species of bats—the long-eared bat (*Mystacina tuberculata*,

Gray) and the short-eared bat (*Chalinolobus morio,* Gray), which, although often local, are occasionally seen in considerable numbers. Both are less frequent than formerly, owing to the destruction of large areas of forest, and possibly to their food having been diminished by naturalised birds. The so-called Maori rat (*Mus maorium,* Hutton), and the Maori dog, long since extinct, were introduced by the Maoris, and used for food. For a long time the Maori rat was supposed to have been extirpated by the black rat (*Mus rattus,* L.), which is especially plentiful in certain parts of the North Island, and the grey rat (*Mus decumanus,* L.), which is established throughout the colony. The Maori rat is, however, still to be found on several islets in the North, and appears to be not uncommon in the northern parts of the South Island. The ravages of the grey rat upon native birds have been repeatedly mentioned, but its partiality for the freshwater bivalve *Unio aucklandicus* is not so well known. In tributaries of the Waikato, where this mollusc is abundant, small heaps of its shells may be seen on the banks with the front margins bitten through by the rodent, which, after extracting the animal, has left the empty shell as a mute witness to his voracity. The mouse (*Mus musculus,* L.) is to be found everywhere, and, when occurring in great abundance, often causes the grey rat to abandon the field. In country districts it feeds upon the seeds of sheep-sorrel, wireweed, and other prostrate plants during the winter season. The injuries effected by the wild cat are too well known to need further mention, and the same may be said of the dog escaped from domestication.

The domesticated ox and the horse can scarcely be said to have exercised any directly deleterious effects on the native fauna, except, perhaps, upon the earthworm; but the sheep, by devouring the food of other animals, has been only less injurious than the rabbit, and, like that unwelcome intruder, ranges from sea-level to the limits of perpetual snow. At present no serious damage has been sustained from the hare. The wild pig, however, has been a terrible enemy to young birds, and, in a few localities, the goat has assisted, by destroying the shrubs which formed their shelter.

In addition to the widespread destruction caused by bringing fern- and forest-land under cultivation, the indigenous fauna has suffered severely from naturalised worms, insects, birds, and mammals—partly through the diminution of the food-supply caused by the invaders; from their superior vigour; often from their predaceous habits; and from their rapid increase, which in many cases has enabled them to crowd the native species off the field. With the exception of the sheep, rabbit, cat, and especially of the stoat, ferret, and

weasel, the greater portion of the injury has been effected by animals which have been introduced through inadvertence or accident.

## Natural Replacement amongst Plants.

Before considering the injuries sustained by the flora from the numerous naturalised plants, it seems desirable to describe a kind of natural replacement which may be observed to a greater or less extent in nearly all forest districts. On forest or scrub being felled and burnt off, unless grass-seed is sown immediately, certain species of fungi or of mosses make their appearance, *Funaria connivens* (Hampe), being perhaps the most frequent; next, the bracken; more rarely, *Gleichenia circinata* (Sw.). The latter, however, is soon overpowered by the former, and the entire area is quickly covered with a luxuriant growth of "aruhe," thus affording a suggestion as to the way in which the wide fern-clad "pakihis" were originally formed and the timber replaced by fern. But a more striking form of replacement is often to be witnessed: a dense growth of the makomako (*Aristotelia racemosa*, Hook. f.) takes the place of the pines and broad-leaved trees which have fallen under the axe. Not infrequently the makomako forms a kind of coppice, the dense growth killing off most of the branches, so that the plants form long, straight rods; the stronger individuals, outgrowing the others, develope branches, and, being thus enabled to assimilate a larger amount of nutritive matter, become more robust, and, gaining complete mastery, prevent the weaker from obtaining their fair portion of air and light, so that at length they die out, leaving the more vigorous specimens to form a makomako grove; these repeat the process amongst themselves, the weakest continually going to the wall, until the undergrowth becomes more or less open, when various shrubs and trees make their appearance, and a new piece of mixed forest replaces the makomako, which has become comparatively rare. In many parts of the Kaipara the first tree to make its appearance after a clearing has been formed is the fuchsia (*F. excorticata*, L. f.), which often occurs in vast abundance, to the exclusion of almost all other plants; it grows less rapidly, however, than the makomako, and is more speedily interspersed with other shrubs and trees. Another plant which often makes its appearance in large quantities after clearing is the poroporo (*Solanum aviculare*, Forst.), which is less permanent than either of the preceding. In 1864, owing to the Maoris having fired upon our troops along the line of the Great South Road, between Drury and the Walkato, the heavy forest on each side of the road was felled for a width of about 2 chains and burnt off, when a

remarkably strong growth of poroporo sprang up, and for many miles both sides of the road were bordered with this plant, which in its turn afforded temporary shelter for many shrubs and young trees, amongst which the totara was remarkably frequent. On the west coast of the South Island, much of the lowland forest when burnt off is temporarily replaced by a robust growth of a large native groundsel (*Erechtites prenanthoides*, DC.), which often attains the height of 5ft., most of it, however, disappearing before the close of the third year, when its place is taken by fern or, more rarely, by shrubs and trees. When the road from Nelson to the Buller was formed through the Hope Valley, about 1870, the burnt area on each side of the road-line was thickly dotted with the rare pine, *Podocarpus acutifolius* (T. Kirk), although very few specimens of the plant were to be seen in the immediate vicinity. It is, however, already overgrown by larger trees to a considerable extent, and affords an instance of a phenomenon often observed by foresters in Europe, where certain plants, as *Pyrola minor* (L.) and *P. rotundifolia* (L.), make their appearance in forests which have recently been thinned, and, after increasing for three or four years, gradually die out, to reappear after the next periodical thinning. Much, however, has yet to be learned with regard to phenomena of this kind in New Zealand.

### Destruction of Kauri Forests.

It is now proposed to trace the principal lines along which injury has been done to the flora, and at the outset to glance at the agency of man. So far as the necessary results of clearing land for cultivation are concerned, they are sufficiently obvious, and have already been mentioned. But they are greatly aggravated and intensified when attention is attracted to the economic value of certain timbers, and the forest is felled at the demand of commerce: the giant kauris, whose branches were waving high in the air long before the civilisation of the West was called into existence, are thrown down, and these grand trees, the growth of many centuries, are in a brief space made available for the thousand requirements of every-day life. But before this has been done rolling-roads have been formed, or tramways laid, involving the destruction of a vast amount of arboreal growth, of elegant flowering shrubs, of fragrant orchids, of delicate herbaceous plants, and of charming ferns, which never again can beautify that scene; for directly the last log has been removed the intelligent bushman, with a recklessness which would be reprobated by a savage, applies a match to the dead branches, for the mere pleasure of seeing the blaze, and not only destroys thousands of promising young trees, but effectually prevents all possibility

of renewal, since the surface-soil, being charged with resin, becomes so intensely heated that all fallen seeds are destroyed, and the site of the forest becomes a desolation, which, after a short interval, is partially covered with an unattractive weedy growth, the seeds of which have been introduced in the wool or hair of animals, or the wings of birds, or blown by aërial currents, after a time to be slightly relieved by patches of bush-lawyer (*Rubus australis*, Forst.) or other uninviting plants. There is probably no greater scene of desolation in the colony than the sites of the large kauri forests in the Kaipara district and on the Cape Colville peninsula. In cases like this the direct and intentional agency of man compresses into a brief space a far greater amount of destruction than would be effected by natural agencies during many centuries.

### Injury caused by Cattle.

Whenever cattle gain access to the forest they browse upon the young shoots, while they consolidate the soil, thus preventing the germination of seeds and consequent renewal; this renders the atmosphere dry, and eventually leads to the destruction of the older trees, although no actual clearing may have been made by man.

Next to man, however, the chief agents in this destructive work are the sheep and the rabbits. Some districts are eaten almost bare by these close feeders, little being left except the tough bases of the silver-tussock (*Poa cæspitosa*, Forst.) and the wiry, ligneous stems of *Muhlenbeckia* and similar plants; even the woolly leaves of some species of *Celmisia* are often closely cropped, the result being that the more delicate plants are all but extirpated over large areas. In a few localities goats have been equally destructive. I have been informed that the tainui (*Pomaderris apetala*, Vahl.) has been completely destroyed at Kawhia, where it was formerly abundant, and is now restricted to the south head of the Mokau River and the Chatham Islands.

### Injury caused by Rats.

Some plants formerly plentiful have been to a large extent destroyed by the pig and the rat (*Mus rattus*, L., and *M. decumanus*, L.), as the curious orchid (*Gastrodia cunninghamii*, Hook. f.), the tubers of which are highly nutritious. This plant has become very rare in districts where the black rat is plentiful. On one occasion, in 1874, I found three remarkably fine specimens, quite 2ft. in height, with tubers 6in. or 7in. in length, and placed them in what seemed a safe place in a hut at Omaha, but during the night they were carried off by the rodents. Both the pig and the grey rat feed upon the fleshy roots of the larger Umbelliferæ.

### Injury caused by Insects.

A small native beetle, which I have not been able to identify, has greatly reduced many species of *Celmisia* and other Compositæ by depositing its eggs on the disc florets, where they quickly enter the larval state, and destroy the carpel before it reaches maturity. The great increase of this insect during recent years is doubtless caused by the frequent burning of the surface vegetation, and consequent destruction of the lizards and predatory insects which kept the beetle in check. Several species of Diptera which are equally destructive doubtless owe their rapid increase of late years to the same cause.

### Displacement by Introduced Plants.

In many instances a comparatively few species of naturalised plants have taken possession of sea-beaches, completely displacing the original vegetation by their more vigorous growth and their vast numbers—simply crowding it out by depriving it of air and light, and to a large extent absorbing its nourishment. This may be seen, for instance, south of the Township of Kaikoura, where a broad stretch of land at the water-margin is wholly given up to such weedy plants as the common brome-grass (*Bromus sterilis*, L.), docks (*Rumex obtusifolius*, L., *R. crispus*, L., &c.), fleabane (*Erigeron canadensis*, L.), catch-fly (*Silene anglica*, L.), Yorkshire-fog (*Holcus lanatus*, L.), and others, perchance intermixed with one or two native plants of similar habit. Here the displacement is almost complete, the original littoral vegetation having been driven to a few peculiarly favoured spots, where it maintains a somewhat precarious existence.

The displacement of the New Zealand flax (*Phormium tenax*, Forst.), the coarse sedge known as toe-toe-whatumanu (*Cyperus ustulatus*, A. Rich.), and the common fern (*Pteris esculenta*, Forst.), by European grasses and clovers is so striking that it has arrested the attention of the natives; and, indeed, it is calculated to attract the notice of even a casual observer, for the indigenous species mentioned are so robust that the mere idea of their being overcome in the struggle for existence by such plants as clovers and grasses seems almost absurd: but the fact remains. Seeds of rye-grass, meadow-grass, white or red clover, &c., germinate by the side of the coarse-growing toitoi, and gradually abstract the moisture which it has been enjoying undisturbed; the growth of the sedge becomes less vigorous, while that of the interlopers is more robust. The result would not be in doubt were the plants now left undisturbed, but an overpowering force comes to the help of the invaders—the rich grass attracts

cattle and horses to graze upon it; this increases the vigour of the grass, while the native plants have to contend against the consolidation of the soil caused by the trampling of heavy stock; this further invigorates the interlopers, and enables them to continually extend their area by giving off new shoots from the base, and occasionally by producing seed. As their growth increases the vigour of the toitoi perceptibly diminishes, and its ultimate extinction is certain, although the process may occupy several years. The occasional replacement of manuka (*Leptospermum scoparium*, Forst.) and other shrubs by grasses is still more striking. Sir George Grey drew my attention to this fact on my first visit to the Kawau, in 1864, where the naturalised *Sporobolus indicus* (R. Br.) was spreading amongst manuka from 5ft. to 8ft. in height, forming a sward which, notwithstanding the coarse character of the herbage, was closely cropped by stock, to the benefit of the grass and injury of the shrub. But even this is less surprising than an instance of a similar kind at the Bay of Islands, where a delicate and slender naturalised love-grass (*Eragrostis brownii*, Nees) is exerting the same influence on a large scale. Introduced grasses exhibit similar action upon many native grasses in all parts of the colony and at all elevations. In the Upper Waimakariri, *Triodia exigua* (T. Kirk) often forms a compact and extensive sward, which is usually able to resist aggression on the part of its indigenous allies, but if a single grain of rye-grass (*Lolium perenne*, L.) or meadow-grass (*Poa pratensis*, L.) falls amongst it and germinates, the continuity of the sward is speedily interrupted and a process of disintegration sets in which ultimately destroys the whole, or reduces it to small tufts or patches. The same result is often exhibited at the expense of more robust plants. The gradual replacement of the spaniard (*Aciphylla colensoi*, Hook. f.) by self-sown pasturage-plants is most remarkable. It seems next to impossible that the large rigid bayonet-like leaf-segments which surround the base of the flower-stem in this strange plant should be injured by a growth of soft herbs, however compact: yet, so it is: dense masses of the spaniard actually impenetrable to stock of any kind are destroyed by this simple agency. When once its vigour is reduced the ultimate destruction of the spaniard is simply a matter of time. The common spear-grass (*A. squarrosa*, Forst.) is often displaced in the same way.

### Amalgamation of Native and Introduced Plants.

But there is another aspect to the case; for, however remarkable it may seem after the statements that have just been made, certain slender native grasses, of great value on account of their nutritive qualities, are able to resist the

invaders, and ultimately become amalgamated with them, to the great benefit of the stock-grower. *Microlæna stipoides* (R. Br.) and *Danthonia pilosa* (R. Br.) are fair examples of this group.

### Replacement by Epacrids.

One of the most interesting instances of replacement that has been observed up to this time is now in progress on the Te Karaka flats, between Papatoitoi and Drury, in the Auckland District. These flats for many miles are clothed with a dense, but not always luxuriant, growth of manuka, manuka-raunui (*Leptospermum ericoides*, A. Rich., *Dracophyllum urvilleanum*, A. Rich.), mingimingi (*Cyathodes acerosa*, R. Br.), &c., the manuka being the prevailing plant. Rather more than forty years ago the late Dr. Sinclair and General Bolton discovered the beautiful *Epacris purpurascens* (R. Br.), a native of New South Wales, in this locality, when it was rightly considered by Sir Joseph Hooker to have been introduced.* Fifteen years elapsed before it was seen by other botanists, when it was found in several places on the flats, presenting the aspect of a truly indigenous plant, and attaining the height of from 2ft. to 6ft. or more. From the great quantity in which it was found I was erroneously led to consider it indigenous, and this conclusion has been generally accepted. †More recently it has been observed in localities fully twenty miles distant. In 1875 three plants of another species (*E. microphylla*, R. Br.) were discovered by A. T. Urquhart, Esq., in the same district. This species is also a native of New South Wales, but has a wider range, extending to Queensland, Victoria, and Tasmania. In three years the plant increased to such an extent that it formed "a dense mass 60 yards in circumference, the intermediate vegetation—*Leptospermum*, *Pomaderris*, and *Pteris*—being almost completely destroyed."‡ In 1887 I had the pleasure of visiting the habitat under the guidance of Mr. Urquhart, and found that not only had the area occupied by the plant been greatly extended, but that colonies had been formed at a greater or less distance from the original centre, and would in their turn form new centres of distribution. Mr. Urquhart also pointed out a very old specimen of another species, *E. pulchella* (Cav.), also a native of New South Wales: this was surrounded by numbers of young plants, which were producing perfect seed, and increasing at a rapid rate. My friend informed me that he had discovered a colony of this species at some distance from the parent plant, but, unfortu-

* Fl. N.Z., vol. ii., pp. 321 and 334.
† Trans. N.Z. Inst., vol. ii. (1869), p. 107.
‡ Trans. N.Z. Inst., vol. xviii. (1881), p. 364.

nately, I had not time to visit it. These three species were alike extending their area mainly in the direction of the prevailing winds, and would, I am convinced, be able practically to replace the indigenous vegetation over the entire area if not interfered with by man. This instance of replacement is replete with interest, as it is almost the only case in which there is clear evidence of the seeds of phanerogamic plants having been carried by aërial currents over a distance of from 1,200 to 1,400 miles and becoming established in a new country.

### Displacement and Increase.

The blue-gum (*Eucalyptus globulus*,* Lab.) in some localities shows itself able to compete with the indigenous vegetation under special circumstances. Seedlings germinating amongst manuka 4ft. or 5ft. in height will speedily overtop it. In several localities self-sown plants are found by thousands, and, as a second generation of naturalised plants is already to be found, there can be no doubt that if not interfered with it would entirely alter the aspect of large portions of the colony. *E. piperita* (Sm.) and *E. rostrate* (Schl.) appear to have the same power of adapting themselves to new situations, although perhaps not to an equal extent.

The brush-wattle (*Albizzia lophantha*, Benth.), a native of Western Australia, is able to destroy the strongest vegetation in open manuka country, as may be seen in numerous localities; while the tan-wattle (*Acacia decurrens*, Willd.) and the silver-wattle (*A. dealbata*, Link.), although much slower, are equally effective in the northern districts. Another Australian plant, *Hakea acicularis*† (Sm.), according to Mr. Cheeseman, "has established itself over several miles of open manuka country at the foot of the Waitakerei Ranges, and is increasing fast." Cobbet's locust-tree (*Robinia pseudacacia*, L.) forms large groves in the Waikato and other localities; its lofty stature and numerous suckers effectually prevent the growth of other vegetation. The well-known furze (*Ulex europæus*, L.), by its dense habit, has killed tauhinu (*Pomaderris phylicifolia*, Lodd.), manuka, &c., over large areas, and is continually extending, while its near relative, the broom (*Cytisus scoparius*, Link.), is no less troublesome. The injury to pasturage caused by the sweetbriar (*Rosa rubiginosa*, L.) is unhappily too well known to need special mention; but few are equally familiar with its power of overcoming manuka and other shrubs of similar habit. The dog-rose (*R. canina*, L.) exerts the same influence to a less extent in several districts of the South Island; while various forms of the European

* Trans. N.Z. Inst., vol. xvi. (1883), p. 383.
† Trans. N.Z. Inst., vol. xv. (1882), p. 291.

blackberry (*Rubus fruticosus*, L.), &c., by overgrowing their unfortunate competitors, deprive them of light and air while absorbing their nourishment.

The tutsan (*Hypericum androsæmum*, L.), although little more than a strong-growing herb, less robust than any of the plants previously mentioned, has become abundant in certain districts, and is able to compete successfully with manuka, karamu, hange-hange, and other shrubs of stronger growth. Its seeds appear to be disseminated by birds.

Two trees may be mentioned here, although they do not perhaps displace the indigenous vegetation to any great extent. They never perfect seeds or give off suckers, yet they have become self-diffused along the margins of rivers and in similar situations to such an extent as to impart a distinct character to the landscape in certain districts. They are the weeping-willow (*Salix babylonica*), a native of Northern China, and the crack-willow (*S. fragilis*, L.), of Northern Europe. Twigs of these trees are easily detached, and are floated by the river to new situations, where they quickly take root and develope with rapidity, so that in certain situations navigation is impeded.

### Introduced Plants on Broken Soil.

Introduced plants compete with indigenous species for the possession of any newly-loosened surface, and especially for waste land. The margins of newly-formed roads are speedily clothed with a dense growth of sheep's-cress, docks, thistles, Yorkshire-fog, and many others, mixed with the native piripiri (*Acæna sanguisorbæ*, Vahl.), toad-grass (*Juncus bufonius*, L.), *Danthonia semi-annularis* (R. Br.), and when neglected form splendid nurseries for injurious insects and fungi. Crumbling places on hillsides in many localities are quickly covered with a strong and permanent growth of the blessed-thistle (*Silybum marianum*, Gœrtn.), which distributes vast quantities of seeds, and overcomes indigenous and introduced plants alike, forming continuous masses of variegated foliage in the early spring, but presenting a ragged and untidy appearance during the autumn and winter months. The common spear-thistle (*Cnicus lanceolatus*, L.) furnishes a striking example of the ability of a plant to seize upon situations suitable for its growth; in many districts immediately after the bush is burnt off the entire area is overrun by this rapacious invader, which exhibits a dense luxuriant growth often 4ft. to 5ft. high, preventing the growth of grass, and forming an almost impenetrable mass. The growth becomes less luxuriant during the second season, so that the grass is able to make headway, and by the end of the fourth season only a few old thistles have retained sufficient vigour to reassert themselves. The so-called Californian thistle (*C. arvensis*, Curtis) is the

only naturalised species capable of injuring pasturage to any serious extent, and, unhappily, it is often the cause of serious loss to the pastoralist and agriculturist. The Gundagai thistle, as it is called in New Zealand (*Carduus pycnocephalus*, Jacq.), flourishes on newly-disturbed soil in many localities, but is comparatively rare on grass-land.

Whenever the finely-comminuted basaltic scoria of the Auckland isthmus is disturbed, a luxuriant crop, chiefly of naturalised plants, speedily makes its appearance, but amongst them one of the most abundant is the indigenous *Chenopodium carinatum* (R. Br.), although not a specimen may have been seen in the vicinity until the surface was disturbed. After the second year the number of plants is greatly diminished, and during the fourth year only solitary specimens are to be found. A similar instance has been observed at Cape Whanbrow, near Oamaru. Whenever the fine silt which covers the surface is disturbed, *Lepidium tenuicaule* (T. Kirk) and the indigenous form of *Atriplex patula* (L.) make their appearance in abundance, although usually both plants are only to be found in small quantity.

### NATURALISED AQUATIC PLANTS.

The increase of the watercress (*Nasturtium amphibium*, R. Br.) in streams and watery places is phenomenal, and attracts the attention of new arrivals on account of the excessive luxuriance and robust growth of the herb, which is not infrequently from 3ft. to 5ft. in height above the water-level, and often impedes the passage of boats. This luxuriance is chiefly due to the mildness of the climate, and has a singular parallel in one locality in England. At the Wyken Colliery the water pumped up from a great depth is of a high temperature, and flows into a stream which expands into a large, shallow pond. As the pond is never frozen, even in the severest weather, the watercress is almost as luxuriant as in New Zealand.

The Canadian water-weed (*Anacharis alsinastrum*, Bab.) simply chokes the River Avon at Christchurch, and has been carried by aquatic birds to other streams in Canterbury and Otago, but is rare in the North Island, being restricted, so far as known to me, to a river near Mongonui, and another in the Bay of Plenty. It is of considerable interest, owing to its being the only submerged aquatic plant that has become naturalised in the colony.

### NATURALISED FUNGI.

Several naturalised fungi are highly injurious to the indigenous vegetation, as the ergot (*Claviceps purpurea*, Tul.), which infests numerous native grasses; the clematis cluster-

cup (*Œcidium clematidis*, DC.), frequently infests *Clematis colensoi* and other species almost to the point of destruction, the stem, petiole, and even parts of the flower becoming thickened and distorted under its attacks: but the limits of this address will not permit me to enter into detail.

## Rate of Increase.

As the number of species more or less completely naturalised in the colony is upwards of five hundred, it becomes a question of some interest whether additions will be made to the catalogue at the same rate during the next half-century as in the past; if so, the number of species of naturalised and indigenous Phanerogams would be about equal, and many of the latter would be crowded out of the field. A satisfactory answer may, I think, be given.

The first catalogue of naturalised plants was published in the original "Flora of New Zealand," vol. ii., p. 321 (1855). It comprises sixty-one species, seventeen of which must be excluded as erroneous, leaving forty-four naturalised species. The second list, published in the "Handbook of the New Zealand Flora," p. 757 (1867), contains 171, from which twenty-one species must be deducted as included on insufficient grounds, leaving 150 species naturalised. A list prepared by the present writer was published in "Transactions of the New Zealand Institute," vol. ii., p. 131 (1869); it embodied all that was then known on the subject, and enumerated 292 species, a summary of which, given at page 146, showed forty-one species erroneously included, or of uncertain position, and 251 species truly naturalised. During the three following years I added fifty-three species to the list, making a total of 304 species known to me at the date of my ceasing to reside in Auckland. In 1882 Mr. Cheeseman published a list of the naturalised plants of the Auckland District, in which he raised the total to 382; but this does not include a few species seen by myself, and still unpublished. At the present time the number of species is certainly over five hundred, as already stated. Making all fair allowance for the imperfection of the records for 1855 and 1869, it will be seen that naturalised species have increased with great rapidity during the last fifty years. But it is not probable that this rate can be maintained; the number of encroaching species suitable for a given habitat, after all, must be limited, and it may well be that the limit for New Zealand, so far as introductions from European countries are concerned, is very nearly reached. As bearing upon this point, it may be remarked that, as many of the naturalised plants of different countries are migrants from a common centre, a large proportion must necessarily be identical; for instance, out of 248 species enumerated by Mr. C.

Moore, F.L.S., as naturalised in New South Wales, fully three-fourths are naturalised in New Zealand also; the remainder, consisting chiefly of plants from warmer countries, are not capable of becoming naturalised here. Again, out of 103 species of plants recently introduced with ballast from Buenos Ayres, eighty-six were already naturalised here.

The distribution of naturalised plants in the colony follows to a very great extent the same lines as those of the indigenous flora: the number of species decreases rapidly southward. Upwards of four hundred and twenty species are found in the Auckland District, but no other district in the colony contains so large a number; less than three hundred species would be found in the Wellington District. It must, however, be remembered that the climate of Auckland is much more favourable to the naturalisation of plants from warm temperate climates than that of any other part of the colony. A singular illustration of this has been recently given. A large quantity of ballast taken on board at Buenos Ayres was discharged at Wellington from a vessel loading for Europe. Over a hundred species of plants made their appearance on the ballast before the close of the second summer, the great majority being plants already naturalised in the Auckland District; twenty-seven species, however, had not previously been observed in Wellington, and of these seventeen species had not previously been seen in any part of the colony. In all probability not more than two of these will become naturalised —most likely only one. But had the ballast been deposited on the light scoria soil of the Auckland isthmus instead of on the stiff Wellington clay it is absolutely certain that in the absence of interference fully one-third would have become established—probably more. I will only add, as an additional reason for not expecting so large an increase in the number of introductions as formerly, that during the last fifteen years great improvements have been made in cleaning garden-seeds, agricultural seeds, and cereals, which will not only tend to reduce the number of species likely to be introduced in the future, but to prevent the yearly importation of certain species which at present are but partially naturalised. Chiefly from this cause certain species, such as *Fumaria officinalis* (L.), *Lepidium campestre* (R. Br.), *Papaver rhœas* (L.), *Githago segetum* (Desf.), *Scandix pecten-veneris* (L.), are less plentiful in many districts than they were twenty years ago.

## Possible Extinction of Indigenous Species.

It is scarcely to be feared that any large number of indigenous species will become exterminated unless under special conditions not yet realised. It has been shown that the aspect of vegetation over large areas may be changed by

displacement, but it does not follow that this would involve the absolute extinction of many, or even of any, indigenous species. Displacement rarely passes into absolute replacement; after it has reached a certain stage the invaders lose a portion of their vigour, and become less encroaching; a portion of the indigenous vegetation becomes gradually inured to light and air, the severity of the struggle becomes less intense, and a gradual amalgamation takes place between the invaders and the invaded, which of itself facilitates the preservation of many of the more delicate kinds, while those less fitted to hold their place in the contest become restricted to those habitats which are of a peculiarly favourable character. The danger of extinction is greatest for those endemic species which are so remarkably local; for instance, *Epilobium brevipes* (Hook. f.), restricted to a solitary habitat on Mount Torlesse, and another in the Awatere, may at any time be destroyed by an unusually hungry rabbit or sheep, and one of the most interesting plants in the colony blotted out of existence. *Clianthus puniceus* (Banks and Sol.) is already restricted to one or two islets where sheep are unknown, and owes its preservation in a wild state to their absence. *Logania depressa* (Hook. f.), *Myrsine montana* (Hook. f.), and *Abrotanella pusilla* (Hook. f.) are in exactly the same position as *Epilobium brevipes*. The list might be increased, but it is needless to mention others.

## Protective Measures.

In 1868 Professor Hutton and myself pointed out the desirability of having the Little Barrier Island proclaimed a reserve for the protection of the native birds, with which at that time it abounded. After the lapse of a quarter of a century this has been partially effected. The Little Barrier Island in the north, and Resolution Island in the south, have been proclaimed reserves for the protection of native birds and plants; but the work of destruction is still being carried on. No serious attempt has been made to place on either island the birds or plants whose existence is most imperilled, although any of the endemic birds or plants of the North Island would find a suitable place of refuge on the Little Barrier, and those of the South on Resolution Island, which is specially adapted to the growth of alpine plants and the endemic species of the Antarctic islands. Owing to the variations from the typical form exhibited by the birds of the Snares, the Auckland Islands, Campbell Island, Antipodes Island, &c., they have attained a high commercial value, and are therefore, at this time, peculiarly exposed to the rapacity of collectors. It is possible to prevent their extinction by the immediate removal of representa-

tives of each species to Resolution Island if the work is taken in hand at once, and the island placed under the care of a skilful curator. If it be postponed for any length of time, who can say what may occur? It would require a very short time indeed to destroy every land-bird on Antipodes Island, or on the Snares; and, now that attention has been drawn to their interest, their value, and to their limited power of flight, the danger has become urgent.

If this address should be instrumental in drawing attention to the danger and accelerating the adoption of protective measures it will not have been given in vain; but I venture to hope that it may be productive of still greater benefit in leading some of those present to investigate the phenomena of change and replacement which are now in progress, and in the results of which we are so deeply interested, before the opportunity has passed away for ever.

## ART. II.—*True Instincts of Animals.*

By CHARLES W. PURNELL.

[*Read before the Philosophical Institute of Canterbury, 1st May, 1895.*]

THE definition of the term "instinct" has been greatly narrowed of late years by scientific thinkers. Formerly, every action of an animal betokening intelligence was attributed to instinct, but latterly the term has been restricted to actions like that of cell-making in the bee, the construction of dams and canals by the beaver, and so forth—actions which are performed in an apparently mechanical manner by one generation after another, and seem to be prompted by some other faculty than intelligence. It is now admitted that many acts done by the higher animals must owe their origin to a faculty akin to, if not identical with, human reason; but the apparently unchanging and invariable nature of such actions as those just mentioned—as the construction of webs by spiders and nests by birds, and the migration of birds—seem to mark off these actions from the variable acts which are done upon the spur of the moment at the bidding of the animal's intelligence.

I think we can restrict the definition still further. Writers upon this subject have not taken sufficiently into account how much the young animal may be taught by the old, and how much it can learn through imitation and from its own observation. The migratory habits of certain birds, for example, are always set down to "instinct"; but birds usually migrate in

flocks, and, in any case, with the young bird it is "follow my leader." The same remark may be made concerning the migratory habits of the Norwegian lemming, the salmon, and other animals. The periodical shifting of their places of abode by certain animals may be regarded as racial habits, in which the offspring are trained by their parents or seniors; and it is no more necessary to assume the existence of a special faculty to account for the habit than it would be to assume the existence of a special faculty in mankind to account for the custom of some human families to shift periodically from the town to the country.

The nest-building habits of birds may be similarly explained, and even such extraordinary habits as that of the Australian Megapodidæ, which build up immense mounds of vegetable and other matter and deposit their eggs in the middle, leaving them to be hatched by the heat evolved from the fermentation of the decaying mass. One member of this family—the *Leipoa ocellata*—forms a pile as much as 45ft. in circumference and 4ft. in height of leaves thickly covered with sand. It is assumed that these birds construct the mounds without teaching or knowledge acquired by observation; but I see no warrant for such a belief. How the racial habit was originally acquired is a fair subject for research; but, having once been acquired, and the propensity incorporated (so to speak) in the bird's mental system, it is easy to comprehend how the young megapod may acquire the art of building a mound, either from direct observation or from seeing other birds perform the work.

The beaver's remarkable habits of constructing dams and water-canals, which, if constructed by human beings, would be deemed proofs of considerable engineering skill, illustrate my proposition. The beavers dwell together in families in artificial habitations called "lodges," which are tenanted by generation after generation. Some of the works constructed by the beaver, too, are of great antiquity, and there is an instance upon record of a beaver-dam which appeared, upon investigation, to be about a thousand years old, and was still in use. The young beaver remains in the parental lodge until the summer of its third year, when it starts housekeeping for itself; so that it has ample opportunity during its residence in the parental domicile for receiving instruction from its elders in the peculiar ways of beaverdom; and when it does begin life upon its own account it still enjoys opportunities of acquiring engineering skill by observing the labours of other beavers, and from its own experience. Probably its earlier works are less perfect than those which it executes when it grows older, just as the nests made by young birds are seldom as perfect as those made by older ones.

Cats and dogs instruct and correct their young; so do monkeys. Tigers and wolves teach their young how to hunt and kill their prey; and, speaking generally, the adult Carnivora train their offspring for the battle of life.

Some of the most remarkable so-called instincts displayed by animals can be accounted for in the same way, and when we come to analyse these instincts we find that they are nothing more nor less than tribal habits, passed on from generation to generation, and acquired in a similar way to that in which the racial habits of mankind are acquired. Let us take for example a singular instinct of the huanaco, or guanaco, a small camel-like animal found in South America. In the southern part of Patagonia there are dying-places of the huanaco, to which all individuals inhabiting the surrounding plains repair at the approach of death in order to yield up the ghost there. "The best known of these dying- or burial-places," says Hudson in "The Naturalist in La Plata," "are on the banks of the Santa Cruz and Gallegos Rivers, where the river-valleys are covered with dense primeval thickets of bushes and trees of stunted growth. There the ground is covered with the bones of countless dead generations." "The animals," says Darwin, "in most cases must have crawled before dying beneath and among the bushes." This peculiar habit of the huanaco seems to be of a local nature, restricted to South Patagonia. In Northern Patagonia, and on the Chilian and Peruvian Andes, where the huanaco is also found, no such instinct has been observed. Mr. Hudson endeavours to account for the origin of this habit by assuming that, in far distant ages, the huanaco "had formed a habit of congregating with its fellows at certain seasons at the same spot; further, that there were seasons of suffering to the animal—the suffering, or discomfort, or danger, having in the first place given rise to the habit. Assuming, again, that the habit had existed so long as to become a fixed immutable instinct, a hereditary knowledge, so that the young huanaco, untaught by the adults, would go alone and unerringly to the meeting-place from any distance, it is but an easy step to the belief that, after the conditions had changed, and the refuges were no longer needed, this instinctive knowledge would still exist in them, and that they would take the old road when stimulated by the pain of a wound, or the miserable sensations experienced in disease, or during the decay of the life-energy, when the senses grow dim, and the breath fails, and the blood is thin and cold." Mr. Hudson's theory is a not improbable explanation of the origin of the habit; but it seems to be an unwarranted assumption on his part that the young huanaco, about to die, proceeds to one of these dying-places without being taught by the adults to do so. The huanaco is

a gregarious animal, and usually goes about in small herds, each containing from half a dozen to thirty animals; but Mr. Darwin states that he saw one herd which must have contained at least five hundred huanacos. Inasmuch as the habit in question is only exercised once during the huanaco's lifetime, and then just before death, and is not wanted as part of its daily round of occupations, it seems rather far-fetched to suppose that the habit is become so ingrained in the mental constitution of the animal that the memory of it invariably revives upon the approach of death, and leads the animal unerringly to a dying-place. Even if we assume that an irresistible desire to seek for a dying-place seizes the animal upon the approach of death, it is difficult to understand how the knowledge of the whereabouts of a dying-place could be inherited. It is a far more likely supposition that if a young huanaco is *in extremis* the older members of the herd expel it from their ranks, as other sick and wounded animals are usually expelled by their fellows, and indicate to it whither it should go.

Traditional and tribal memories, perpetuated by communication from old to young, will account for such habits as the hive-making habits of the bee and the domestic and military habits of the various species of ants, which are so commonly regarded as typical of the more wonderful development of instinct in the lower animals. Even Charles Darwin, calm philosopher as he is, writing about the intelligence of ants, rapturously observes, "The brain of an ant is one of the most marvellous atoms of matter in the world, perhaps more so than the brain of a man." In point of fact, an ant does not possess a brain, although it does possess an assemblage of ganglia which in the higher animals develope into a brain. The large number of ants and social bees which dwell together in communities, and the rigour of their social organization, make the education of the young ant or bee a matter of comparative ease. It is born into the midst of an active community, living day after day on a system of unchanging routine, and the young ant or bee naturally falls into step with its fellows. A child born and bred in a camp would naturally acquire military habits. The young ant, nevertheless, seems to receive special instruction from its elders. Romanes, summing up the results of the observations made upon this subject, says, "The young ant does not appear to come into the world with a full instinctive knowledge of all its duties as a member of a social community. It is led about the nest, and 'trained in a knowledge of domestic duties, especially in the case of the larvæ.' Later on the young ants are taught to distinguish between friends and foes. When an ants' nest is attacked by foreign ants the young ants never join in the fight, but confine themselves to removing the

pupæ; and that the knowledge of hereditary enemies is not wholly instinctive in ants is proved by the following experiment, which we owe to Ford: He put young ants belonging to three different species into a glass case with pupæ of six other species, all the species being naturally hostile to one another. The young ants did not quarrel, but worked together to tend the pupæ. When the latter hatched out an artificial colony was formed of a number of naturally hostile species, all living together after the manner of the 'happy families' of the showman."

Amongst the hive-bees, the younger ones are usually left at home with a small number of older bees to perform the internal work of the hive while the remainder of the older bees go out to collect honey and bee-bread. What deduction can be drawn from this fact save that the younger bees are gradually trained to a knowledge of their duties as members of the community? Even bees of mature age seem to teach one another. Huber saw a bee building upon the wax which had already been put together by her comrades. But she did not arrange it properly, or in a way to continue the design of her predecessors, so that her building made an undesirable corner with theirs. "Another bee," says Huber, "perceived it, pulled down the bad work before our eyes, and gave it to the first in the requisite order, so that it might exactly follow the original direction."

Of course, the fact that many so-called instinctive acts are really the products of education and experience does not clash with the view that animals may be, and probably are, born into the world with a hereditary predisposition to certain tribal habits which render instruction in the performance of those habits easier and more effective than it would otherwise be, just as some human families are endowed with musical gifts, and the children in such families more readily acquire the technical skill necessary for the efficient exercise of the musical art than children of families destitute of such special gifts. The mental like the bodily structure of any single animal is the sum and outcome of all its progenitors' faculties; and, just as its body is better fitted to perform certain acts than others, so its mental organization is better fitted for certain mental operations than it is for others. Body and mind are correlated, and work in unison. The web-building spiders secrete web-building material in their bodies, and possess highly-specialised organs enabling them to produce the material in such manner and abundance that it can be used in the construction of snares. And, as this specialised anatomical structure has gradually been evolved from simple beginnings, the mental faculty required for the construction of snares has been evolved with it. The spider

may be said to be endowed with mental as well as physical spinnerets. Those oft-repeated acts which are required for the preservation of the animal's life become so interwoven with its mental fabric as to be inseparable from it, and performed almost mechanically. Hence, the newly-born animal, inheriting a special bodily structure, and a mental endowment corresponding with it, is apt and ready to perform such acts even without special education. It may be taken for granted that any human being with his bodily organization intact would in process of time learn to walk of his own accord, even if placed in circumstances which had precluded him from seeing any other human creature walk, or from receiving any instruction in the art of walking.

If we eliminate all such habits as may have been acquired without teaching or observation, we shall find left comparatively few fixed habits of animals which, in the present state of our knowledge, cannot be accounted for by the individual having received instruction from its fellows or gained knowledge from its own observation; and it is to such habits that I propose to restrict the term "instinct." For the purposes of this paper I will call them "true instincts." These instincts are confined almost exclusively to insects. By way of illustration I will take the case of the caterpillar of a butterfly (*Thekla*) referred to in Darwin's "Posthumous Essay on Instinct," printed as an appendix to Romanes' "Mental Evolution in Animals." This caterpillar feeds within the pomegranate; but when full-fed gnaws its way out (thus making the exit of the butterfly possible before its wings are fully expanded), and then proceeds to attach with silk threads the point of the fruit to the branch of the tree, so that it may not fall before the metamorphosis of the insect is complete. Hence, the larva works on this occasion for the safety of the pupa and of the mature insect which it will never see; and there is apparently no means by which it can receive instruction, since no visible intercourse takes place between the butterfly which laid the eggs from which the caterpillar is produced and the caterpillar. When considering this problem we must firmly grasp the fact that, although the caterpillar, the pupa, and the mature insect—the butterfly—are, to outward seeming, three distinct animals, in reality they are but varying phases of the same animal; just as the infant, the boy, and the man are one and the same human being, but in different stages of existence. The difference in the outward aspect of the insect in the several phases of its existence is indeed the more striking, but the essential facts of the phenomenon are the same. The caterpillar, the pupa, and the imago form the various stages of the insect's life-cycle, just as the progress from early infancy to old age forms the life-

cycle of the human being. Therefore, if it be the case that the insect possesses the power of inheriting memories, we can understand how the memory of an inherited habit, useful and common to one phase of the animal's existence, may readily be transmitted from the perfect insect to its offspring through the various stages of that offspring's existence. The order in which these memories are transmitted will be the order in which they will manifest themselves in the new life-cycle. The question therefore is, Does the *Thekla* possess the power of transmitting the memory of that habit to which I have referred? Is it possible for a habit like this to become so ingrained in the mental constitution of the insect as to be capable of transmission from parent to offspring, in like manner to that in which the bodily structure is transmitted? It appears not unreasonable to suppose that such may be the case. The life of an insect is short and monotonous, and its range of locomotion limited. Its world is a small world—a fragment of the larger world in which man lives and moves and has his being; there is little scope for variation of habit, and the insect's habits of life must consequently tend to become stereotyped. Therein it differs from the higher animals, whose mental powers are kept active and mobile by being constantly exercised upon fresh subjects. As the mental nature of the animal grows more complex, instincts become more rare, because the animal exercises more choice in its actions. Even the minds of human beings, however, when kept within too narrow grooves, are apt to become largely mechanical in their actions, as is evidenced by certain Eastern nations, which follow the same habits and customs as were followed by their forefathers thousands of years ago. If, then, any particular habit became stereotyped upon the animal's mental system (of course, I use the term "stereotyped" in a strictly metaphorical sense, and for the purpose of rendering my meaning clearer) it would be transmitted from generation to generation in the same manner as the other mental qualities of the race were transmitted; for, whatever view we may take of the nature of mind, it cannot be denied that animals of the same race exhibit similar mental capacities; and hence we must conclude that the offspring owes its mental constitution to its parents just as much as it owes its bodily constitution to them, although the environment of any individual may develope mental as well as bodily peculiarities in that individual. Nor would the fact that the *Thekla* butterfly is the offspring of two parents affect the matter, because the habit or instinct above mentioned is common to both, and hence would be transmitted by both.

The fact that the nervous system of the Invertebrata is fundamentally different from that of the Vertebrata is full of

significance when we reflect that true instincts are almost confined to members of the former branch of the animal kingdom, seeing that it is through the nervous system that the mind of the animal finds expression.

Amongst true instincts I should class such acts of protective mimicry as those performed by the Phasmidæ. Here is a description by Professor Drummond of one of these creatures found by him in tropical Africa: "Take two inches of dried yellow grass-stalk, such as one might pluck to run through the stem of a pipe; then take six other pieces nearly as long and a quarter as thick; bend each in the middle, at any angle you like; stick them in three opposite pairs, and again at any angle you like, upon the first grass-stalk, and you have my Chirombo. When you catch him his limbs are twisted about at every angle, as if the whole were made of one long stalk of delicate grass, hinged in a dozen places, and then gently crushed up into a dishevelled heap. Having once assumed a position, by a wonderful instinct he never moves or varies one of his many angles by half a degree. The way this insect keeps up the delusion is indeed almost as wonderful as the mimicry itself; you may turn him over and over and over, but he is mere dried grass, and nothing will induce him to acknowledge the animal kingdom by the faintest suspicion of spontaneous movement." We know too little of the life-history of the Phasmidæ to assert positively that their practice of shamming death (which is Drummond's interpretation of their action, or rather inaction) is not taught the young by the adults, but it seems improbable. The insect has inherited its peculiar bodily structure from its ancestors, and this structure readily lends itself to the practice. The instinct seems to be brought into play not only in the presence of actual danger, but also as a precaution against possible danger; and it may be that it is done unconsciously, like those reflex actions so common amongst the higher animals, many of which seem to be relics of what were manifestations of active intelligence in the past, but are now become mechanical responses to outward stimuli. Moreover, we must not forget that some animals of low organization are of an extremely lethargic disposition, and will remain motionless for hours, or even longer periods—our New Zealand tuatara may be taken as an instance—and it is possible that the "mimicry" of Professor Drummond's "Chirombo" may be partly attributable to this cause.

We may also class as indications of true instincts the fear which young animals, including children, usually manifest towards what is really dangerous to them. Young children, for example, usually show signs of fear on being plunged into the sea. The late Dr. Romanes once turned loose a ferret into

an outhouse which contained a doe rabbit with a very young family. The doe left the young ones, and the latter, as soon as they smelt the ferret, began to crawl about in so energetic a manner as to leave no doubt that the cause of the commotion was fear, and not merely the discomfort arising from the temporary absence of the mother. This fear is not, however, universal amongst young animals, as is proved by the result of some experiments recently made by Professor Lloyd Morgan, and related by him in *Nature* (11th October, 1894). He put some young pheasants, about a day old, which had been artificially hatched out of the egg by means of an incubator, in close proximity to a fox-terrier; but, although the dog was keen to get at them, and trembling with excitement in every limb, the young birds exhibited no signs of fear. They also showed no fear of a large blindworm, but pecked at its forked tongue, its eye, and tail. Mr. Douglas Spalding made a number of interesting experiments upon the young of our domesticated animals, the result of which he published in *Macmillan's Magazine*, which went to show that chickens, young ducks, and pigs, and other newly-born animals, are capable of performing many acts apparently betokening intelligence without instruction. He found that very young chickens were able to pick up small specks of food and scrape in search of food; that newly-born pigs sought the mother's teat almost immediately after birth; and that, on placing four ducklings a day old in the open air for the first time, one of them almost immediately snapped at and caught a fly on the wing: all of the experiments being conducted in such a manner as to preclude the possibility of the young animal having learned to do these things by imitation. In considering these experiments, however, it must be borne in mind, as I have pointed out in my treatise on "The Intelligence of Animals," that the young fowl, duck, or pig comes into the world with its intelligence pretty fully developed—although it afterwards gains wisdom from experience—and all such acts as those just mentioned are intelligent acts, not acts performed in an unvarying fashion, but acts varying with the surrounding circumstances. There seems, indeed, nothing more remarkable in a chicken scraping up the ground in search of food than in its walking, and chickens do not require to be taught how to walk.

What I have denominated true instincts suggest an analogy with reflex actions. Herbert Spencer, indeed, regards instinct as compound reflex action, by which I understand him to mean a sequence of reflex actions manifested in immediate succession to one another; while Dr. Romanes regards such so-called instincts as the hive-making instinct of the honey-bee as being reflex actions into which is imported the element of consciousness. It seems to me, however, that singleness is of

the very essence of a reflex action: the action may be complex in its manifestation, but it is essentially one act; while "consciousness" and "reflex action" are contradictory terms. An action is styled "reflex" because it is performed without consciousness on the actor's part. Moreover, a reflex action is unchanging in its manifestation. Let the stimulus be applied and the appropriate and responsive movement follows automatically. Now, even such apparently fixed habits as the hive-making habit of the bee vary with circumstances, and in some countries the hive-bee abandons its usual practice of collecting honey altogether. In like manner, birds often change the structure of their nests to suit localities, while the migratory habit is sometimes lost. Beavers, suffering from man's persecution, have been found to cease building dams, and to become solitary in their mode of life. The supposed analogy between what are commonly called instincts and reflex actions therefore fails; nor will it hold as respects true instincts, since the latter generally involve a succession of acts directed towards a fixed end, and I see no ground for assuming that these acts are not consciously performed by the animal. It may further be observed that, whereas true instincts are seldom met with outside the Insecta, reflex actions are exhibited by all classes of animals, including man himself.

## Art. III.—*The Ancient Tribe Te Panenehu.*

By Captain Gilbert Mair.

[*Read before the Auckland Institute, 12th October, 1895.*]

The following account of an ancient tribe called Te Panenehu, the descendants of a chief named Ngatorohaka, who came in the Nukutere canoe from Hawaiki, was given to me by an old man of the Whakatohea and Ngapotiki Tribes at the hearing of the Whitikau Block, Opotiki, 1880:—

Nukutere was the canoe which sailed from Hawaiki about the same time as Matatua canoe, of which Toroa was captain. She landed at Waiaua, near Opotiki. The people who came in Nukutere were called Te Wakanui, and Ngatorohaka was their chief. These people multiplied and spread all over the Opotiki Valley and adjacent country, Te Kareke Tribe occupying Ohiwa, the Ngatai and Te Whananapanui settling between Torere and Te Kaha; but the three latter were a distinct people, their forbears having come in Matatua.

Seven generations had passed, and Tutamure was the dominant chief. He had given his sister Taneroa in marriage

with one of Kahungunu's people, who lived in Kakaparaoa Pa, on the Waikohu-Matawai Block, near Turanga. They had nothing but fern-root to eat, and Taneroa constantly repined for the abundant food at her brother's place at Opotiki; so her husband, Rongomainotai, one day said, "Well, if food is so plentiful there, let us go to Tutamure." Accordingly they went, but on arrival were only given some cold kumara to eat. Rongomainotai exclaimed, "If this is all we can get here, better to have lived on the fern-root at Kakaparaoa." He was very angry, and returned to his own place, stealing on the way some seed-kumara belonging to Tutamure. By-and-by, when Taneroa heard that he had an abundance of food, she followed him; but he, without speaking one word to her, went off to Turanga. Thither she followed, so he moved on to Nukutaurua. She overtook him there, and he fled towards Wairoa, telling his people to kill Taneroa if she persisted in following after him, and they did so.

When Tutamure heard of his sister's death he assembled a war party and killed a number of Kahungunu's people, eventually attacking that chief in his pa, called Maungaakahia, at Nukutaurua. As the *ope* (war party) drew near, Kahungunu asked who was the leader, and Tutamure answered, "*Tama i hongia te Whakarua ka rangaranga te muri, ka tere tamure*" (When the north-east wind blows, and the sea-breeze drives the waves into ridges, then is the *tamure* (snapper) seen). The opposing parties fought, and Tutamure's wooden spear (*huata*) and *taiaha* were both broken, so he armed himself with a *patu paraoa* (a whale-bone weapon), exclaiming, "*Taua i te huata, taua i te ake, tangohia i te ika nui a tu kanapa napa ana te paraoa ki runga o Maungaakahia, ka ora taua nei ka nenehu*" (Having fought in vain with spear and *taiaha*, then seizing weapons made from the whale, the great fish of the war god, the whale-bone flashes over Maungaakahia, I triumph over my foes, who disappear). This boast or speech of Tutamure's passed into a proverb, and his descendants henceforward were known as Te Panenehu. After the fight Kahungunu sued for peace, and, Tutamure consenting, Kahungunu offered him his sister, Tauhei, to wife. Now, Tutamure, though an exceedingly brave man, was an ill-favoured and insignificant-looking person; and when he went to a spring close by to adorn himself and saw his reflection in the clear water his heart failed him lest Tauhei should not return his affection; so he said to his young brother Taipunoa, who was handsome, "Take you Kahungunu's sister Tauhei for your wife, so that peace may be established between us and them." Taipunoa did so, and Tauhei bore him a son, whose name was Mahaki, who begat Ihu and Whakara, from whom are descended all the Hitaagua, Mahaki, and Ngapotiki Tribes. The

spring where Tutamure looked on his plain features is called to this day "Te Waiwhakaata a Tutamure" (Tutamure's looking-glass).

Some time after this Ngaitai quarrelled with the Panenehu, defeating them at Waikurapa. The quarrel was about pigeon-preserves in Whitikau and Whakapaupakihi Blocks. Ngaitai again attacked them at Otaitahu and Waireporepo. Then the Panenehu gained a victory at Ruruarama. Ngaitai retaliated by murdering two chiefs named Tukuaterangi and Rongomaiaia. Again they defeated the Panenehu with great slaughter at Waikoni, driving the remnant to Turanga. Eventually they returned, defeating the Ngaitai at Aururangi and at Paripapoa. Ngaitai were obliged to flee to Hauraki, taking with them the body of a Panenehu man called Tarahamama to eat by the way. They were subsequently expelled from the Thames district for having bewitched the son of Tuterangianini. They were kindly received by the Panenehu, who had by this time adopted the name of Te Whakatohea. Having murdered a Whakatohea woman named Tohikirangi, they fled to Turanga, but had to leave on account of trouble with the wife of Toroa Apukai. The Whakatohea again gave them shelter, and gave them two women of rank in marriage—Hinepare and Waimarama. After this, and when Taraia was a young man, Tuterangianini, the great chief of Ngatimaru, came to seek payment for the death of his son. He fell upon the Whakatohea at Waiaua, killing many hundreds. The fight took place on the beach, and, as the incoming tide rolled the numerous slain about on the sands, the battle was called "Te Paengatoitoi" (the shoal of toitoi-fish cast ashore). The remnant of the Whakatohea escaped to Turanga, but, a number having been killed by Ngatikahungunu at Kakaparaoa and Waikohu, they returned to Opotiki to find that Ngaitai had occupied all their country.

So they were made to suffer for the sin of Ngaitai in bewitching the son of Tuterangianini; and then these people tried to take their lands. However, they gave battle to Ngaitai, killing many at Awahou, and at Ahitarakihi, where the Town of Opotiki now stands, and so regained possession of their ancestral lands.

The Panenehu used to deposit their dead in a very large pukatea tree called "Te Ahoroa," which stood on the left bank of the Otara River. There was a hole in the top, 50ft. or 60ft. from the ground, and the dead were hoisted up and thrown in.*

* In 1881 some settlers living up the Opotiki Valley reported having discovered a great quantity of human bones. I immediately visited the spot, and found it was the place described by Maiki Whenua as Te Ahoroa ("the long line"). An enormous pukatea tree, some 22ft. in girth, had fallen against the hill-side, and, splitting open, disclosed cartloads of skeletons. I counted 397 perfect skulls, but an equal number, probably, had crumbled away, or been broken up by the trampling of cattle.

I will give my genealogy from Ngatorohaka:—

Ngatorohaka.
Hitewhatu.
Te Meremere.
Te Whatu.
Tamatete.
Tunanui.
Hanenepounamu.

| | | |
|---|---|---|
| Tutamure. | Taneroa. | Taipunoa = Tauhei. |
| Manutauhere. | | Mahaki. |
| Rongoteaki. | | Ihu. Whakara. |
| Tauirarangi. | | |
| Tauirakorero. | | |

| | |
|---|---|
| Kahukura te Ahu. | Tamawhakauka. |
| Te Aotahi. | Te Whena. |
| Te Owheru. | Whiripare. |
| Te Manawa. | Te Puritanga. |
| Te Painga. | Rangihuatini. |
| Anoa. | Hineheni. |
| Mawe. | Punahamoa. |
| Te Aporotanga.* | Ngapata. |
| Te Awanui. | Maiki Whenua. |
| (Twenty-one generations.) | (Twenty-one generations.) |

* In 1864 about eight hundred rebel natives from the East Cape, Tekaha, and Opotiki came up the coast with the object of forcing their way through the Arawa country to assist the King natives in Waikato. The loyal Arawa defeated them at Lake Rotoiti, and drove them back to the coast. They then attacked Maketu, but were again defeated and driven back towards Opotiki. The Arawa overtook them at Tekaokaeroa, near Matata, and killed between sixty and seventy, pursuing them to Te-Awa-a-te-Atua, and capturing their canoes. One of their principal chiefs, Te Aporotanga, was desperately wounded and taken prisoner. On the Arawa side, Tohi te Ururangi Winiata Pekamu, a man of high rank and a great warrior, was mortally wounded while directing the attack. About a dozen others were wounded, including Apiata, a Ngatiwhakaue

I will shortly furnish you with some notes on Maori musical instruments, and also give some particulars respecting two other bone flutes (*koauau*) now in the Auckland Museum.

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chief, who had his eye carried away by a musket-ball. About midnight it was seen that Tobi te Ururangi's end was approaching. Large fires were lighted near, and the chiefs, gathering round, wept over their dying leader, and addressed him with farewell speeches, making complimentary reference to his great deeds in many a past battle. His faithful old wife sat supporting his head, overwhelmed with grief. The other wounded men lay near in pain and anguish. It was a solemn and touching scene; yet it had its comic aspect when, as the old warrior's spirit was about to depart, his wife (Mata), overcoming for the moment her grief, rose up and, addressing the chiefs, said, "You have bidden farewell to my lord according to our usual custom and in the language of our ancestors; but it would be more appropriate for me, who have been educated in a missionary family, to speak in English." Then, turning to her dying husband and affectionately clasping his body, she exclaimed, "*Kuru pai mi poi. Hau a iu? Were were, taikiu ha.*" (Good-bye, my boy. How are you? Very well, thank you, sir.) These few words comprised her whole stock of English, and were uttered with feelings of apparent pride. In a few minutes all was over, then Mata was heard whispering to Apiata and asking how to load a gun. Those standing by did not interfere, as they thought she was about to shoot herself and accompany her lord to the spirit-land, as the widows were wont to do. Indeed, it would have been a gross breach of etiquette to have interfered. However, she had no such intention, for, having loaded the musket, she shot Te Aporotanga dead, saying he was to wait upon her husband in the next world. A reference to the genealogical table shows that Te Aporotanga was twentieth in descent from Ngatorohaka. Old Tohi te Ururangi carried from a string round his neck Tutanekai's bone flute, "Te Muriraugaranga," which is now in the Museum. A few minutes after his death, Pokai te Waiatua came to the body and tried to take away the flute unperceived, but old Mata managed to detach it from the string and thrust it into the dead man's throat for concealment, whence it was removed next day on arrival at Maketu and given to Ngahuruhuru Pango (Tutanekai's lineal descendant), who gave it to me on the occasion of the defeat of Te Kooti at Ohinemutu on the 7th February, 1870. Touching this same flute, I may state that it was made from the armbone of a tohunga named Te Murirangaranga, who lived in the time of Whakane.

Shortly after Tutanekai's birth Whakane called upon this tohunga to perform the baptismal rights over his son—*te tohi o Tu*, or dedication to the war god. Having performed this sacred office, the priest became strictly *tapu* during the lunar month, according to Maori custom, during which time he could not touch food with his hands or feed himself. However, before his purification (*horohoronga*) had been accomplished he was seen one day at Paparata, on the edge of the forest behind Ohinemutu, gathering and eating poroporo berries. This was equivalent to cursing Tutanekai, and a deadly insult to Whakane, so he had the unfortunate tohunga put to death by drowning (it being unlucky to shed the blood of a priest), and had the right armbone made into a flute for Tutanekai. When Tutanekai grew up he became famous for his skill in playing this instrument, and his descendants the Ngatitutanekai still pride themselves upon their ability to emulate their ancestor in this respect.

## ART. IV.—*The History of Otakanini Pa, Kaipara.*

By S. PERCY SMITH.

[*Read before the Auckland Institute, 5th August, 1895.*]

THE Maori documents sent by Hami Tawaowae to Mr. Fenton when he presented the *tiki* from Otakanini Pa to the Museum have been placed in my hands for translation. Knowing something of the old history of the Otakanini Pa, which I gathered from one of the principal chiefs of the Ngati-whatua Tribe in 1860, I have added a few explanatory notes to Hami's history.

The Otakanini Pa is situated on a navigable creek, which joins the Kaipara waters about six miles south of Aotea Bluff. It was a strong pa in former days, having the deep, muddy creek on one side and swamps on all others. The hill on which it is built is about 100ft. high, and, as usual, is terraced and fortified on top. It is somewhat celebrated in Ngati-whatua history as having been besieged on more than one occasion.

At the foot of the hill on which the pa is built a spring gushes forth, from which, in former times, the inhabitants obtained their drinking-water. Tradition says that it was in going to fetch water from this spring that Rona struck her foot against a stone, and therefore cursed the moon, which just at that moment had gone behind a cloud. The result was that Rona, as punishment for her impiety, was taken up to the moon, where she may be seen to this day, as any old Maori will tell you. This is a capital illustration of the localisation of a world-wide myth, which the Polynesians brought with them from the far-west in their migrations, and which is known to probably all branches of that race. Even the Ainu people of Japan have the same story. With us it is "the man in the moon," not a woman.

The first occasion on which we hear of Otakanini in Maori history was in the time of Maki, a great man who lived about ten generations ago, and who was the principal chief of the Nga-riki or Nga-iwi Tribe, that formerly owned the whole of the southern Kaipara district and the Isthmus of Auckland, as far as the Tamaki River. It was these people who built the great pas around Auckland. For some reason not now known, Maki attacked and took the Otakanini Pa, and killed a great many of its inhabitants.

It was about the time that Maki flourished that the Ngati-whatua Tribe first made its appearance in the Kaipara district, having conquered their way down from the North

Cape and from Kaitaia. It was not, however, until the time of Kawharu, Hakiriri, and Te-Ati-a-kura, about six or seven generations ago, that they advanced so far south as Kaipara proper. Their advance was due to some murders committed by the Wai-o-hua Tribe—a branch of Nga-riki—and who at that time occupied Otakanini and the adjacent country. Amongst others who were killed by the Wai-o-hua people was Hau-mai-wharangi, and it was to avenge his death particularly that the expedition, which finally conquered Kaipara, left the Wairoa, where Ngati-whatua were then living. One part of this expedition was under the command of Pou-tapu-aka, Papa-karowa, and Ati-a-kura. They landed near Otakanini, and occupied the hill just above where Te Otene lived, at Papurona, in 1860. They found Otakanini Pa too strong to take by a rush, and so adopted a method of siege which was not at all uncommon in former days. It has been denied by a well-known authority on Maori matters that the Maoris ever used any projectile weapon: the following will prove the contrary. The description of the Siege of Otakanini was given to me by Te Otene, the most learned man of Ngati-whatua alive in those days, and one well acquainted with the tribal history. As we sat on the same hill his ancestors occupied, as described above, he explained that Hakiriri and his men plied the pa with spears from that position, thrown by means of the *kotaha* or *kopere*, and, although the distance is some 150 yards, the besiegers made it so hot for those within the pa that they dare not come outside. Under cover of this shower of spears an advance was made, and the Pa of Otakanini finally taken, with very great slaughter. It was explained to me that the spears used were made of long, straight manuka poles, cut on the bank of the creek just below where we were sitting, and that, after having their ends sharpened by burning in the fire, they were thrown by aid of the *kotaha*.

Many of us have seen this method of propulsion, no doubt, as used by the Maori boys in play. The spear is struck into the ground on a slant, inclined towards the direction in which it is intended to fly. A short stick, about 18in. long, with a string at one end, is used to propel the spear. The short stick is, in fact, just like a whip. The string or thong of the whip is twisted round the spear in a peculiar manner, so that it will readily come undone. The operator, standing on one side, with a strong jerk, draws the spear out of the ground, and propels it to a long distance. Te Otene told me that a spear cast in this manner was capable of piercing two men at once, especially if thrown so as to descend at a high angle.

This siege occurred about six generations ago. Hakiriri was Te Otene's great great grandfather. From estimating

Te Otene's age at seventy in 1860, this would make the date about the year 1690 or 1700, if not before. It was not long after this that the Ngati-whatua conquered all the country from Kaipara to the Tamaki, and practically exterminated the whole of the Wai-o-hua Tribe, who were its then owners.

We now come to Hami te Waewae's narrative:—

Ko nga korero tenei o tenei pa, o Otakanini, e tu nei i roto o Kaipara.

Ko Tauhia te rangatira o tenei pa. Tona iwi, ko Ngati-whatua. He moko-puna ia na Pokopoko-whiti-te-ra. He pa toa tenei i ana whawhai katoa. Ko te pa tenei i whakatankitia: "Ko te pa o te Aitanga-a-Tiki"; o "Tetaetaea"; "Te tunga o te totara." Ko enei whakatauki, he whakatauki mo te iwi rangatira. "Ko te ringa heke tohu nui a Tangaroa"; "Ko te whare o te manuka"; "Ko te pokopoko o Rotu"; "Te autete awhea." Ko enei whakatauki, he whakatauki mo te toa ki te whawhai.

This is the history of the Otakanini Pa, which is situated at Kaipara.

Tauhia was the chief of this pa, and his tribe was Ngati-whatua. He was a grandson of Pokopoko-whiti-te-ra. The people of the pa were celebrated for their bravery. There are several "sayings" in reference thereto: "The pa of the descendants of Tiki"; of "Tetaetaea"; "where stands the totara." These are all sayings applied to a high-born people. The other sayings are in reference to the courage of the people in war.

The above are mottoes or sayings descriptive of the bravery of the people and the strength of the pa. Pokopoko-whiti-te-ra was a celebrated ancestor of the Ngati-whatua Tribe, who was a great peacemaker in his day; hence, in making peace, if it were likely to be lasting, it was said to be like those of "Pokopoko-who-causes-the-sun-to-shine." He was also celebrated as a *taniwha* slayer, and many places in Kaipara are pointed out at this day as the former dwelling-places of noted *taniwhas* that were killed by him. Rotu, mentioned in one of the "sayings," was the wife of Maki, already referred to.

Ko tetehi o nga pa o Tauhia ko Rangi-te-pu. Kotahi mano te ope a Takurua i eke ki te whawhai ki taua pa. Rokohanga atu, ko Tauhia i te pa, toko-ono nga hoa, ko ia ka toko-whitu ai; ko tona whaea ka toko-waru. Te ingoa o tona whaea ko Koieie, he tamahine na Pokopoko. Ka mea atu a Koieie ki tana tamaiti—ki a Tauhia, kia kakahuria ana kakahu mo te whawhai. Katahi ka whakakakahuria e Koieie, ka tiaina tona matenga ki te raukura—ara—ki te kotuku. Katahi ka mau ki tana patu; te ingoa o te patu, ko "Nga-tai-i-turia-ki-te-maro-whara." Heoi; te taenga atu o te ope a Takurua, ka karanga atu nga hoa ki a Tauhia

Another pa of Tauhia's was Rangi-te-pu. On one occasion Takurua came with a thousand men to assault that pa. On their arrival they found Tauhia in the pa, with six comrades, he making seven, and his mother eight. His mother's name was Koieie, and she was a daughter of Pokopoko. Koieie told her son (Tauhia) to dress himself up in his garments of war. She proceeded to help him, and decorated his head with a plume made of the feathers of the kotuku (or white heron). He then seized his weapon, which was named "The-tides-fought-with-the-war-girdle." When the army of Takurua approached, his companions called

(me te wiri ano o ratou), "E! ka kapi te whenua i te nui o te ope!"

out to Tauhia (at the same time trembling for themselves), "Ah! the land is covered by the greatness of this army!"

Katahi a Tauhia ka karanga atu, "Moku anake ano ena hoa-whawhai; kahore mo koutou." No reira, ka nui te hari o ana hoa, a, ka mutu te mataku.

Katahi ka peke atu a Tauhia ki te patu i te ope a Takurua. Tokorua ki te hinganga i tana patunga kotahi; no konei ka whati te ope, a, patua haeretia e ratou ko ana hoa, a, hore rawa atu he tangata i ora. Me te rangatira hoki, me Takurua, mate katoa.

Tauhia replied to them, "These enemies are coming for me alone, not for you." In consequence of this his companions were very glad, and they no longer feared.

Tauhia then sprang forward to combat the army of Takurua. Two of them fell at the first blow; hence the army fled, and they were followed up by Tauhia and his companions, who killed them as they ran, so that not one escaped. The chief Takurua was also killed with the rest.

Katahi a Koieie ka piki ki runga ki tetehi puke, ki Puke-kowhiwhi, ka karanga, "Kei te whetu au e! kei te marama!" No reira i rongo mai ai taua iwi—a Ngati-whatua—i matau ai hoki, kua hinga te parekura a Tauhia. Na, ka whakahua te hari a Tauhia ratou ko ona hoa i muri i te hinganga o ta ratou parekura:—

Then Koieie ascended a hill named Puke-kowhiwhi and shouted out, "I am as the stars, as the moon!" Hearing this, her tribe—Ngati-whatua—knew at once that Tauhia had won his battle. Tauhia and his companions then repeated their song of triumph after the battle:—

> Aue! uhi mai te waero!
> A, ko roto ko taku puta!
> A, he puta aha te puta?
> A, he puta tohu te puta,
> A, e rua nei, ko te puta-e!

[I do not attempt to translate this—the words have no sense, the meaning it originally had being lost. It is not by any means an uncommon *hari* or species of song used to accompany the war-dance.]

I muri i tenei, ka hoki mai a Tauhia ki tona pa, ki Otakanini, a, taea noatia tona matenga.

After this, Tauhia returned to his pa at Otakanini, and dwelt there until his death.

Tauhia, mentioned above, was the grandson of Pokopoko-whiti-te-ra, and son of his daughter Koieie, who married Whai-whata. Tauhia lived four generations ago; many of his descendants lived at Te Kawau, Kaipara, in 1860. Te Waru was Tauhia's son by his second wife, Matangi.

He tokomaha nga uri o Tauhia, erangi, e rua anake nga mea i haere ki te whawhai—ara—ko Te Waru, ko Te Wana-a-riri.

Ko ta Te Waru nei ope, i ahu ki Ngapuhi, a, horo katoa te pa o Ngapuhi. Te ingoa o te pa, ko Te Tuhuna. I muri i tera, ka horo ano tetahi atu pa; te ingoa o te pa, ko Tai-a-mai. No konei ka houhia te rongo, a, ka hoki mai a Te Waru me taua ope katoa ki Otakanini. Huaina ana te ingoa o tena parekura "Ko te patu turoro."

Tauhia had many offspring, but only two of them ever engaged in war, namely, Te Waru and Te Wana-a-riri.

Te Waru's army went to the Ngapuhi country, where he took a pa belonging to that tribe, called Te Tuhuna. After this he took another pa, the name of which was Tai-a-mai. In consequence of this, peace was made, and Te Waru and his army returned to their pa at Otakanini. These battles were called "Te-patu-turoro."

I muri i tenei, ka haere te ope a tona teina, a Te Wana-a-riri, ki Ngapuhi ano. Ka tutaki ki a Ngapuhi ki Moremonui; a, katahi ka whawhai; ka mate a Ngapuhi. Huaina ana te ingoa o tenei parekura ko, "Te-kai-a-te-karoro." Ka houhia ki te rongo, a, ka ora nga mea i ora, me Hongi Hika. Otira, ko te rangatira nui o te ope, ko Pokaia, i mate. Heoi ka hoki mai a Te Wana-a-riri me taua ope katoa ki Otakanini.

After this, the army of Te Waru's younger brother, Te Wana-a-riri, went to Ngapuhi. They met the latter tribe at Moremonui, and there fought a battle in which Ngapuhi were defeated. This battle was called "The-food-of-the-sea-gull." After that peace was made; those who were not killed escaped, amongst them Hongi Hika. But the principal leader of the Ngapuhi army, Pokaia, was killed. So after this Te Wana-a-riri and his army returned to Otakanini.

Ko nga take enei i haere ai a Hongi Hika ki Ingarangi, ki a Kingi Hori, ki te tiki pu, paura, me taua kakahu mata.

It was on account of these defeats that Hongi-Hika went to England to King George to fetch guns, powder, and his coat of mail.

The expedition under Te Waru took place in the early years of this century, and the cause of it was as follows: Pokaia, a great chief of Ngapuhi, ardently desired to marry Kararu, a sister of Hongi Hika; but the lady was obdurate and would not consent. To escape Pokaia's attentions she married an old man named Tahere, of Kaikohe. Pokaia, wild with rage, adopted a plan of giving vent to his feelings which is not at all uncommon in Maori history. He raised a war party and wantonly attacked Taoho, a chief of Kaihu, and slew many of his people. To obtain revenge for this, Ngati-whatua made the incursion into the Ngapuhi country, in which Te Waru joined as related above, and met with such success that Ngapuhi in honour bound could not do less than wipe out the disgrace that had fallen on their arms. Pokaia and Hongi raised a war party of five hundred strong, and advanced on Kaipara by way of the west coast. They were met at Moremonui, on the beach about ten miles south of Maunganui Bluff, and, after a very severe fight, Ngati-whatua gained the victory, killing Pokaia, Te Waikeri, Hou-awe, Tohi, Tu-karawa, and many other leading men of Ngapuhi. The bodies were left on the beach (such as were not consumed) in such numbers that they were eaten by the seagulls—hence the name of the battle, "Te-kai-a-te-karoro." This defeat was one of the main reasons why Hongi went to England with Mr. Kendall in 1820 to obtain arms with which to chastise Ngati-whatua and the Hauraki Tribes, who had both defeated Ngapuhi very seriously. The result was a series of slaughters—too numerous to mention here—which ended in the complete victory of Ngapuhi, and the devastation of the whole of Kaipara and the Auckland Isthmus for many years.

I te hokinga mai o Hongi Hika i Ingarangi ka whawhaitia e, ia nga iwi o runga—ara—o Rotorua, o Nga-

On the return of Hongi Hika from England he made war on the tribes of the south—namely, Rotorua,

tiporou, o Ngati-maru, o Waikato. I muri i enei whawhai, katahi ka huri mai ki a Ngati-whatua. Ko te ingoa o te pare-kura ko "Te Ika-ranga-nui." Heoi, hinga ana a Ngapuhi, hinga ana a Ngati-whatua, engari i riro te papa i a Ngapuhi. No konei ka haere a Te Tinana ki Waikato; tona taenga atu ki reira, ka puta te whakaaro o Ngati-to-ata ki te rangatira o Ngati-mania-poto, ki a Tu-korehu, kia patua a Te Tinana, a, patua ana, mate ana. Ko te take tenei i haere ai nga iwi e rua, a Ngapuhi, a Ngati-whatua ki Waikato, ki te taki i te mate o Te Tinana. No reira i mate ai a Pomare me Te Whare-o-riri, me etahi atu o nga rangatira o Ngati-whatua. Engari, ko te nuinga o nga rangatira i ora, a hoki mai ana ki Kaipara nei.

Ngati-porou, Ngati-maru, and Waikato. After this he turned towards Ngati-whatua. The name of this battle was Te Ika-ranga-nui. Here both Ngapuhi and Ngati-whatua fell, but the victory remained with the former. [This was in February, 1825.] It was in consequence of this defeat that Te Tinana [of Ngati-whatua] went to Waikato; on his arrival there the Ngati-te-ata Tribe persuaded the chief of Ngati-mania-poto, named Tu-korehu, to kill Te Tinana, which was done. This death, again, was the cause that the two tribes of Ngapuhi and Ngati-whatua went to Waikato to seek revenge for Te Tinana's death. In consequence, Pomare, of Ngapuhi, and Te Whare-o-riri, of Ngati-whatua, were killed, besides others [at Te Rore, 1826]. At the same time most of the chiefs of Ngati-whatua escaped, and subsequently returned to Kaipara to dwell.

Ka moe tetahi wahine o Ngati-whatua i tetehi tangata o Ngati-te-ata; katahi ka tikina ano taua wahine e Ngati-whatua, ka tangohia mai. No reira i puta ai te whakaaro o Ngati-te-ata, puta noa i Waikato, kia whawhaitia a Ngati-whatua. No taua takiwa i hangaapoutia ai tenei pa, a Otakanini, i whakaarahia ai hoki tenei Tiki; ko tona ingoa ko "Te Whare-o-riri." Ko te tangata nana i whakaara tenei Tiki, ko Mate, ko tetehi o nga rangatira o Ngapuhi. Otira, kahore i tae mai a Waikato.

Subsequently one of the Ngati-whatua women married a Ngati-te-ata man, when the former tribe took her away from her husband. Hence, the Ngati-te-ata Tribe, together with the Waikatos, proposed to make war on Ngati-whatua. It was at this time that the Pa of Otakanini was rebuilt, and the Tiki—which is called Te Whare-o-riri [after the chief of that name]—was erected. The Tiki was set up by Mate, one of the chiefs of Ngapuhi [who lived at Puatahi, Kaipara, in 1860]. But the Waikato people never came after all.

E toru nga tau i tu ai tenei Tiki ki Otakanini, ka whawhai nei a Hone Heke ki te pakeha, i Kororareka.

The Tiki had been erected about three years at Otakanini when the war between Hone Heke and the Pakehas commenced at Kororareka [1844].

He kupu poroporoaki enei naku, na Hami Tawaewae, ki a "Te whare o-riri":—

Ka tōtō nga kohu e—i roto o Kaipara,
I te puna whakatōtō riri, e,
Na o tupuna, na o matua nga ki-e,
He tahuri waka nui,
E kore e ngaro-e,
He kopua nganangana i rangi.
Me tuku atu koe ra,

These are my farewell words, of Hami Tawaewae, to "Te Whare o-riri":—

The misty clouds in Kaipara gather
In the anger-propelling fountain;
'Twas thy ancestors, thy parents declared.
'Tis like the wreck of a great canoe,
Which will never be forgotten—
Like a deep-red cavity in heaven.
From hence thou must depart

Nga whare o Kuini,
Ka tapua koe ra,
Te hua o te waero,
He taonga ruru tonu-e,
I roto te whare kino,
Ka he nga hau-e,
I a tatou, e te iwi-e!

Haere e Kara! e Te Whare-o-riri! Haere atu i roto o Kaipara! Haere atu ki roto ki nga whare nunui o to taua iwi, o te Pakeha!

Me mihi atu koe ki o tatou hoa Pakeha ina tae atu kia kite i a koe! "Ko ahau tenei, ko Te Whare-o-riri, e mihi atu nei ki a koutou."

Tena koutou, me to tatou Kuini Wikitoria. Ma te Atua ia o tiaki, e hoatu hoki te kaha, kia kaha ai ia ki te whakamarama i nga ture pai mo tatou, kia rite te kupu o te Waiata cxxxiii., 1: "Na, ano te pai, ano te ahuareka o te nohoanga tahitanga o nga teina, o nga tuakana, i runga i te whakaaro tahi."

Heoi ano aku mihi ki a koutou; Tena koutou! Tena koutou! Tena koutou!

Na HAMI TAWAEWAE.

To stately mansions of the Queen,
And there be sacred kept,
With many dog-skin garments.
Thou art a treasure closely prized
In the depths of this gloomy heart.
The winds seem gone astray
With us, O people!

Go, oh sir! Te Whare-o-riri! Go hence, depart from Kaipara! Depart to the mansions of our European people!

Thou shalt greet our friends the Pakehas when they come to visit thee, saying, "'Tis I, Te Whare-o-riri, that salutes you all."

Salutations to you all, and to our Queen Victoria! May God protect her, and give her power and strength to enlighten us with good laws, that the words of Psalm cxxxiii., 1, may be fulfilled: "Behold! how good and how pleasant it is for brethren to dwell together in unity."

This is all my greeting to you. Salutations! Salutations! Salutations to you all!

From HAMI TAWAEWAE.

## ART. V.—*Volcanic Activity in Sunday Island in 1814.*

### By S. PERCY SMITH.

[*Read before the Auckland Institute, 5th August, 1895.*]

I HAVE been favoured by my friend W. D. Campbell, Esq., F.G.S., with the following account, abstracted from the *Sydney Gazette*, 17th September, 1814, of the first known eruption on Sunday Island, of the Kermadec Group. In vol. xx. of the "Transactions of the New Zealand Institute," page 333, I furnished some notes on the geological formation of Sunday Island, and described an eruption in Denham Bay which took place about 1872; but that described in the *Sydney Gazette* is of much earlier date, though the place is the same. This first eruption appears to have taken place on the 8th March, 1814, and was of the same nature as the subsequent one, an island of loose volcanic matter having been formed in both cases. All signs of this island had disappeared on the occasion of our visit in the "Stella," in 1887. The following is the extract:—

"Sunday Island.

"Ship News.—The following remarkable account of one of those convulsions of nature which the mind contemplates with surprise and awe we receive from Captain Barnes, of the 'Jefferson,' who witnessed the phenomenon. We have stated, in reporting the 'Jefferson's' return to this port in the *Gazette* of the 3rd instant, that she had gone from hence in June, 1813. Much of the intervening time has been occupied about the coasts of New Zealand, on the north side of which is Sunday Island (one of Curtis's) [*sic*], and the subject of the present account, lying in 29° 12′ S. lat. and 178° W. long.

"From the 24th to the 27th Captain Barnes was employed in wooding there, and while the boats were on shore the vessel sailed to and fro within a spacious bay on the west side of this island, formed as a crescent, the heads of which were about six miles asunder. Actuated by a curiosity which must be always serviceable to navigation—that of discovering the surroundings of every part which vessels frequent—Captain Barnes employed himself attentively in the business of sounding between these heads, and in no part found less than 45 fathoms. Further in the depth gradually diminished, and, after penetrating till within a short distance of the inner shore, he there found 16 fathoms. Leaving the island on the 27th of February, it was afterwards frequently in sight till the 9th of March, when, at the distance of six or seven leagues, a thick cloud of a dark smoky appearance was observed above it the whole day, and shortly after midnight a flame burst forth, which rose to an excessive height, and filled the atmosphere with a strong, fetid, and an almost suffocating vapour, which was felt on board, though then at a distance of about seven leagues. Captain Barnes returned to the island in two months, for the purpose of wooding, as before, and found the appearance of the place entirely altered, and that an island occupied the spot where so short a time before he had found 45 fathoms of water. It is about three miles in circuit, kidney-shaped, its outer edge nearly forming a line with the heads or opposite points of the entrance of the former bay, which lays north and south, has a small bay of its own fronting the ocean, and is covered with a coarse grit. On the near approach of the ship's boats the water became very warm, and at length intensely hot. It was still smoking, and was then evidently an unquenched mass. Its position is not mid-channel, but extends considerably more towards the north shore than the south. A passage through the opening of the north side would be impracticable, owing to the numerous rocks which are scattered through it; but

that on the south seems rather inviting to vessels in want of temporary accommodation, with a safe anchorage. Captain Barnes has subsequently fallen in with the 'King George' (Captain Jones, of this port), and, on relating the above circumstance, received information from him that the 'King George' had been there shortly before the 'Jefferson,' and that he (Captain Jones) had himself also sounded between and within the heads, and could find no soundings at all with a common lead-line in those places where Captain Barnes had found a depth of only 40 fathoms. The idea that suggested itself, from comparing Captain Jones's information with Captain Barnes's own observation, is that this eruptive pile was probably in the act of growing out of the abyss when the latter was there and got soundings at 45 fathoms, the depth diminishing as he went nearer in. The visible extent of its surface, added to the vast height to which it must necessarily have arisen, must fill the mind with astonishment. That Vesuvius might have sprung originally from the like cause is not impossible. Its first eruption took place in the first century of the Christian era; and we do not find anything more remarkable in what is recorded of those that have since taken place than the throwing-up a mountain in one night, in the year 1583, three miles in circumference and a quarter of a mile high; while the island reported to have been thrown up in the bay of Sunday Island may be considerably larger, as its summit is three miles round, and it appears to have a gradual and not a steep ascent.—*Sydney Gazette*, 17th September, 1814.

"In reference to the above account, it might be as well to mention that, until Lyell's researches into geology were made, no distinction was made between mountains of upheaval and deposition. It was not understood that a volcano could be formed by ejecta, and built up with that material; hence the comparison of Vesuvius with the Sunday Island incident, which seems to have been largely a local terrestrial upheaval, probably bursting into eruption when the crust of the earth was relieved of the superincumbent weight of water. —W. D. CAMPBELL, F.G.S."

## Art. VI.—*On Dusky Sound.*

By Richard Henry, Government Resident in charge of Resolution Island Reserve.

Communicated by Sir James Hector.

[*Read before the Wellington Philosophical Society, 17th July, 1895.*]

Remembering the interest you take in such things, I venture to send you the following about Dusky Sound. I have been nearly all through it now, and its islands; also up Acheron Passage, into Breaksea, and into Wet Jacket as far as the island.

Boat-harbours are everywhere, and altogether it is a safe place for boating, when we have camping outfit on board. I have a young fellow with me, and intend to keep him as long as I can. We have been often on Resolution, in many places; all round it, except on Five Fingers; and we have cut tracks upon two mountains on this side of it, which we have been up on six different occasions, but saw no signs of life above the bush except parrakeets and the tracks of rats. There is a good deal of tussock above the bush on Mount Phillips, and it is a grand mountain to climb, the peak is so sharp and lonely —800ft. above the bush—whence can be seen nearly all the sound with its many islands, and the greater part of Resolution. The latter appears to have high, rough mountains all round it, with lower and smoother land in the centre, the outlets being Duck and Cormorant Creeks; but there is nothing like a flat anywhere, and just one little lake south of Useless Harbour. Roas and woodhens are plentiful in the bush, with nearly all the small birds, including crows and thrushes; but there are no kakapos nor grey kiwis. The kakapos on the mainland are breeding this year, so I did not like to disturb their curious arrangements by removing them, especially when I found that there were plenty in favourite places; but there are long stretches of coast without any. On the south side of Dusky, east of Cooper Island, there are two great landslips, some hundreds of acres, covered with green scrub, where we heard them drumming in dozens in January. And in February, under Mount Foster, at the mouth of Wet Jacket, I found three nests in about an hour; also further up, at our camp opposite the island, I found several nests, each with two little young ones. I never found a male near a nest, and I think they know nothing about it. The mother tramps away and carries home food so industriously that she is all draggled and worn, and near the end of her task she becomes

so exceedingly poor that sometimes I thought she would die; yet her young ones are just balls of fat until about the end of May, when many of them are as heavy as the largest old males. But soon after she ceases to feed them they rapidly become poor. The fruit that they have been fed on is nearly all done, and I think that many of them die before they learn to forage for themselves. All this time the old males are very fat, which shows that they did not exert themselves to feed the young—more likely they took the best of everything for themselves. Resolution as a whole is not a good place for kakapos, because tutu and fuchsia are scarce; but there are many places on it where colonies will do well, where fig-trees are plentiful. I noticed that there were no "gages" where the kakapos were; in fact, I have seen none on the mainland, but plenty on all the islands, where there are no kakapos; and if the birds eat them they will have plenty on Resolution. I will have most trouble to get grey kiwi, for I have heard very few in all this place. When camped on Cooper Island we heard grey kiwi there—and it is a big island, perhaps eight square miles in extent; and, though it comes near the mainland at its eastern end, there is mostly a swift tide running there that will disturb the calculations of a swimmer. In November, kakas, tuis, and mokos were here in great numbers feeding on the honey of the rata-blossoms, but no pigeons until lately, when they have come for the berries, and the kakas are nearly all away. There was a kaka's nest, with two young ones, near our house on Pigeon Island. When we came here, in July, there were colonies of crested penguins at nearly every easy landing, and sometimes in caves, all busy nesting. They all went away for a while with their young, but came back in January and February for their moulting, and then cleared out again, and I do not think there is one left in Dusky. But many of the little penguins seem to remain here, and are always out fishing in the daytime, coming ashore at night and sleeping in holes under rocks and trees. We never saw one per cent. of the crested penguins out either day or night, and I do not understand them at all. Woodhens are on all the islands, and attend closely on the penguins when the young are just hatched, so that may have something to do with the penguins staying at home so much. Grey ducks are numerous at the head of Dusky, where they have a splendid breeding-place among creeks and swampy islands in the mouth of a great valley coming in from the north, and there are no swamp-hawks.

There is a fine river coming in from the east to Supper Cove. I went up it about three miles to a gorge, where I was stopped by a dangerous but passable place. There are

three rapids, but the portages are easy, and I intend to take a canoe up there next summer, for I could see a kindly-looking valley turning to the north-east, and I may be able to go a long way up it.

Paradise-ducks are very scarce here, because there is no grass for them. Even at Goose Cove—which may have got its name from them—where there is some level land, there is no grass, as it is all grown over with scrub; and there are neither ducks nor geese there now, only a few redbills and swans. Up in Wet Jacket it was quite pitiful to see a pair of paradise trying to rear a family on a few square yards of grass. If I had a few pairs of goats I think I could provide the ducks with grass-plots in suitable places at the ends of bays. It is not a heavy task to dispose of some of this scrub; and surface-sown rye-grass grows here more quickly and richer than I ever saw, but there are hundreds of seedling forest-trees and shrubs growing up among it, so that some animal is required to keep them in check that the grass may continue. In old England, Darwin mentions how pines and other forest-trees sprang up when the animals were excluded, and so it may be in any country as it is here. The scrub follows down the alluvial land at the mouths of creeks, covering every foot, and even reaching out over the tide, so that nothing else has a chance under present circumstances. There are often little natural clearings at landslips and uprooted trees, which seem insignificant, but great changes are often wrought by long-continued trifles. This mountain-bush, being of great extent and unknown resources, may contain room for another Switzerland, with its hardy mountaineers. But now, with its superfluity of damp and sandflies, it is about the most miserable and useless place that man ever set his foot in, and he cannot have the heart to start reclaiming it from its present state; but the quadrupeds may be the pioneers, as they have been in nearly every other country, and then the men can take it up. We often see where the sealers have rolled aside the stones on the beach to land their boats, and perhaps a level place with a grove of young trees on the site of their old camp, but not a yard of open ground; yet two of those parties lived here for about a year. And two vessels were built in Dusky Sound, but we have not yet found where their shipyards were, for perhaps not a trace remains. When we came into the little harbour on Pigeon Island the stones were rolled aside on the beach, but there was not room above high water to land our stores until we made a clearing. We thought that no one ever lived there before until we cleared and dug the ground, when we found it nearly paved with Maori ovens. In Cascade Harbour there is the site of a hut with an iron chimney which may have been ten or twelve years deserted, yet the floor of

the hut and its surroundings were covered with a tall grove of koromikos, some of them 3in. thick. Now, I think that if a hardy race of goats existed here they would have altered all this for the better; they would have kept many grassy openings, and made pathways in the bush, to the advantage of the explorer and prospector, and also to the advantage of the ground-birds—because those birds were plentiful at Te Anau for forty miles along the lake, but the best place for them was near grassy openings under Mount Luxmore. There on a quiet evening in 1880 there used to be a perfect din of their various calls, and the individuals were the best of their sort. However, the birds may only be temporary residents here on the mainland; but one would think that it is the duty of this generation to liberate some suitable animals in this bush. Deer might do, but I think they are too wild and shy, and that a well-clad, hardy race of goats would be best, to pave the way for more useful stock, and, in the meantime, to provide food and sport for the future pioneers. We have often seen goat-skins used as hearth-rugs; they would make good jackets for this climate, and would be valuable. Some people will object to goats or anything else, for fear of encouraging wild dogs; but the native dog died out here (though it could have lived well on kakapos), because every cave and den is damp and mouldy, and it would require a special breed of dogs to live here in a wild state.

We saw the king-fish up the sound. Three big fellows swam round our boat within arm's length, and I knew them. The same day we saw a great company of them right at the head of the sound: that was on the 5th February. The horse-mackerel and mullet were here all the summer in shoals; also another little fish, which I could not find in either of the books on fishes. They are of some importance, because they have been very plentiful all the time we have been here, and are very good to eat. I call them "latris" for want of a name.* They will not take bait, but come into the shallow water at our door every evening, and just at the last of the light they are easily speared, so that I often get half a dozen in a few minutes; but with a suitable net they could be caught in thousands. But we only see them round Pigeon Island. Moki are very plentiful, but we only get a few trumpeter now and then. Of course, the cod and groper are plentiful, also butter-fish and barracouta. We were in want of a name for the little prawns like shrimps, and called them "squid." All the fish are after them, and it is wonderful how they can stand it. When we see the mackerel splashing along we know they are after squid; the mullet, latris, and parrot-fish are

* *Mendosoma lineata.*

always after them, and even the moki and butter-fish join in the hunt. We saw the gulls pecking at something in calm water, also the terns and little white gulls, and found it was squid they were eating. I thought the barracouta only hunted little fish, but found them full of squid. Though they continually hunt the shoals of fish they seem to catch very few, for we found none in those we caught for our dogs, so it seems likely that they only take the laggards and leave the main body flourishing. The squid are lively little fellows, and flit about so quickly that the smartest of their enemies have some trouble to catch them. On calm warm afternoons they are all at the surface, and then there are acres of water that seem alive with fish. Surely the squid that survives all this must be the best of his race, or, at least, the most artful and active. We first saw them in Useless Harbour in September, when they were tiny creatures only a quarter of an inch long. At Christmas the main body were about an inch long; but since then small ones were numerous, so that I think there may be several crops in a season. In April they have almost disappeared.

## Art. VII.—*The Ceremony of* Rahui.

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 12th August, 1895.*]

I have made several attempts to gain information on this now obsolete custom of *rahui*—one time practised by the Polynesian peoples—both privately and also by a short article published some time back in the Magazine of the Polynesian Society, but have been unsuccessful in persuading any person to take the subject in hand. This being the case, I am left to work out a theory of my own, which is the subject of this paper. It is a thousand pities that no person having time and opportunity to investigate and work out the history of this remarkable custom should have inquired thereon some years ago, previous to the death of the witness Noa Huke, whose evidence is quoted herein:—

*Rahui.*—In the case Airini Donnelly *v.* Broughton, published in the supplement of the *Hawke's Bay Herald*, Napier, 26th March, 1892, the witness Noa Huke says, "The whole of this block [of land] from Te Whanga to Puketitiri and Titiokura, at Mohaka, was affected. That land was given to Te Rangi-ka-mangungu and Tutura. They went and put up *rahuis* all

over it. At Puketitiri, Piko (a man) was the *rahui;* at Oingo (Hauhau) was Kauhourangi, another man. The whole of the land was thus made sacred, even the eel-weirs." In the evidence of another witness, referring to a different portion of the land, some chiefs "impaled a woman there." These points were specially dwelt on by Sir Robert Stout in his summary of the evidence. But no explanation was given as to what this ceremony consisted of, neither was it shown in what manner the above-named men were ultilised as *rahui*.

Of myself, I see no reason to doubt that these unfortunate men were buried at the foot of posts erected at certain places, perhaps even when still alive, or were lashed to the posts by the sacred cord; this being done to increase the *tapu* of those places, and to prevent by this *tapu* the removal of such posts at any future date.

In Tregear's Maori-Polynesian Dictionary is given, "*Rahui* —To protect by a *rahui*—*i.e.*, by a mark set up; to prohibit persons from taking birds, fruit, &c., or to prevent them from trespassing on lands, &c., made *tapu*." For good instances of tribal *rahui*, see "Maori Customs and Traditions," by John White, bound up with "History and Traditions of the Maori," by T. W. Gudgeon.

We find the following definitions in a Paumotuan dictionary by E. Tregear: "*Rahui*—A defence, forbidden; Maori, *rahui*, to prohibit; Hawaiian, *lahui*, to forbid."

In "Traditions and Superstitions of the New-Zealanders," Dr. Shortland, at page 316, gives *whaka-ihi, he tapu, he rahui*, as of the one meaning. At page 265: "Having matured his plans, Heke came suddenly, cut down the obnoxious flagstaff without opposition, and then went home again. Afterwards, when Governor Fitzroy set up a new one, Heke appealed to this act as a further argument in support of his cause. 'See,' said he, 'the flagstaff does mean a taking-possession, or why else should they persist in re-erecting it?' This remark referred to a common practice in New Zealand—namely, that of *setting up a post* on a spot of land which any one desires to claim as his own. When two tribes contest the right to any place, one of them will set up their post, their antagonists will soon after come and cut it down; but, probably, either party will take care not to meet the other on the disputed ground till the post has been cut down and re-erected several times; when, if neither party will yield, the dispute at last ends in a fight."

Nothing is said here as to utilising a man as a *rahui;* and this remarkable evidence of Noa Huke remains unaccounted for. Will none of our members of the Hawke's Bay Institute search this matter out before those who might explain are alike "gathered to their fathers"?

There are four place-names in the district which may possibly owe their origin to the aforesaid setting-up of *rahui* on the land, two of which—Puketitiri and Titiokura—were mentioned by Noa Huke. The other two are Waititirau, the site on which stands Mr. J. H. Coleman's house, and Wakatu, or, as I suppose it to be rightly spelt, Whakatu, near Tomoana.

The name Puke-titi-ri has no reference to the bird titi, a large petrel, generally spoken of as the "mutton-bird." Different varieties of these petrels are often heard and dimly seen when passing overhead on a summer evening in the gloaming on the way from the sea to their nests in holes excavated in the light pumice soil of the mountain-ranges far inland—possibly a distance of forty miles or more. They mostly travel in pairs, somewhat apart, and must return again to the sea before daylight, yet I have never detected them on the return journey. These birds also nest in great numbers on the small islands near the Bluff, Southland, and also those near Stewart Island.

The Southern Maoris visit the islands each season and collect the young birds from the nests, at which time they are extremely fat. They are partially cooked, and then packed away in the large bladder-like portions of a kelp or coarse seaweed, and are, as it were, imbedded in their own fat, which aids in their preservation. This industry is a yearly harvest to the southern Maori.

To return to my subject: We have *Puke*, "a hill"; *titi*, "of the setting-up"; *ri*, "of the mark" which no person dare to pass over. Surely this must be one of the places where *rahui* was set up. Why are we unable to discover the exact spot where this special *rahui* was erected? The second word mentioned by Noa Huke was Titiokura, which divides thus: *Titi*, "the setting-up"; *o*, "of"; *kura*. This word *kura* has a variety of meanings, as "red in colour," "a wreath or head-dress," &c.; and the painting the posts supporting a house with red-ochre was a symbol indicating the *tapu* or sacredness of such building. We find the word Whare-kura used by the Polynesians to denote the sacred building where the young priest-chiefs (*ariki*) were taught mythology, history, agriculture, astronomy, &c. This house was very *tapu*: no women were allowed to come near it, food was cooked at a distance and brought by special messengers. I have no doubt *kura* in this instance was an allusion to the chief supports of the building being painted red, as an indication of its sacred character.

In support of this theory I quote the following from "Traditions of the New-Zealanders," by Dr. Shortland (page 112): "In former days the huts used in travelling by sacred

persons were always distinguished by their posts being daubed with red-ochre, to prevent the law of *tapu* being inadvertently broken; and for the same reason sacred persons painted their bodies and clothes with the same red substance, that they might leave a mark behind them where they rested."

I think we may safely conclude that the name Titiokura was given to that place at the setting-up of *rahui* there. Waititirau is rather a difficult word to decide upon. Some might take it thus: *Wai*, "the water"; *titi*, "of the mutton-birds"; *rau*, "in number a hundred." But, taking the evidence of the two place-names already deciphered, it seems that we may safely claim it as a site of a *rahui*, making it *Wai*, "the water" (near which); *titi*, "was set up"; *tirau*, "the peg": or, "the water of the sticking-in of the peg." In this word I suppose that there should originally have been a third repetition of the syllable *ti*, as Wai-titi-tirau, and so including the terminal *tirau*, "a peg."

My fourth name, Whakatu, would seem to be related to the remarkable word *tutututu*, "to stand erect"; and is a compound of *whaka*, which is called a prefixed causative, and mostly indicates "to cause," or "to make to do": therefore, Whakatu means, "to cause to stand"; or, more correctly, "to erect or set up; a place where something was erected or set up"; and in all probability indicates "the place where *rahui* was set or put up." It is not reasonable to make *waka*, "a canoe," *tu*, "standing erect," as the original meaning of the name.

Dr. Shortland says, "The word *tapu* is used in the same sense in the Sandwich Islands, in the Society Islands, and, as far as is known, in the other islands of Polynesia. It is probably derived from the word *ta*, 'to mark,' and *pu*, an adverb of intensity. The compound word *tapu*, therefore, means no more than 'marked thoroughly,' and only came to signify 'sacred' or 'prohibited' in a secondary sense, because sacred things and places were commonly marked in a peculiar manner, in order that every one might know that they were sacred. The fundamental law on which all their superstitious restrictions depend is that if anything *tapu* is permitted to come in contact with food, or with any vessel or place where food is ordinarily kept, such food must not afterwards be eaten by any one, and such vessel or place must no longer be devoted to its ordinary use, the food, vessel, or place becoming *tapu* from the instant of its contact with an object already tapu."—("Traditions and Superstitions of the New-Zealanders," page 101.)

At first sight I was taken with the likeness of the place-name Motiti ("Flat Island" of Cook) to those mentioned above, and even thought that it might mean "the place of

the mutton-bird" (petrel); but on further consideration it became apparent that the word Motiti was an abbreviation for Motu-iti, "the small island." Such being the case, we have here a warrant to suppose that certain other place-names may also be clipped or shortened—notably, the name Wai-titi-rau, already spoken of as originally in its full significance being Wai-titi-tirau.

At the same time, it may be that this name has been imperfectly written and understood by the pakeha. Possibly it might be Wai-titiro, "the water of looking at"—*i.e.*, a looking-glass to reflect the image of a person—or "the place of the distant view." As I am unacquainted with this spot, and its position or history, this question must be left open, and might be decided by some one consulting the Maoris in that district.

A remarkable use of the word *rahui*, together with a tragical incident of early pakeha days, is given by Dr. Shortland in "Traditions and Superstitions of the New-Zealanders," page 234:—

"In the more lawless and savage days of the New-Zealanders a trading vessel came into the harbour of Tauranga to purchase a cargo of flax. . . . No cargo was at the time procurable, and the captain was persuaded by one of the chiefs of Ngapuhi Tribe to take his ship to Whakatane, about forty miles distant, being led to believe he would there obtain plenty of flax without any difficulty. The chief sent one of his men in the vessel, ostensibly as a guide, but he was really the bearer of a message as fatal as that contained in the letter given to Bellerophon, for it was a hint to the chief of Whakatane to seize the vessel and all the property in it.

"The Ngapuhi chief knew that he could attempt nothing against this ship while at Tauranga, for it was there under the protection of the natives of the place, who carried on a profitable trade with foreigners, which would have been ruined completely by an act of violence. He therefore conceived the idea of making both ship and cargo a present to the less scrupulous natives of Whakatane, in order that he might claim a share of the spoil. The captain fell into the trap, and, attempting to defend his vessel, he and his crew were all killed, and the vessel was then plundered and destroyed.

"A secret is seldom, if ever, well kept by the people of this country. With the news of the fate of the unfortunate ship, its cause, and the very words of the message, '*Tenei tou rahui poaka*,' were reported at Tauranga. . . . Nini, after expressing his resentment against the perpetrators of the deed, demanded of the chief of Ngapuhi, who was present, if it was true that he had sent the message to Whakatane which led to the catastrophe. The chief did not deny it. 'Then,' said

Nini, 'you shall be payment for the white men'; and with these words he shot him."

This message Dr. Shortland translates, "Behold a herd of pigs made sacred for you." This is incorrect, as giving the double meanings of *rahui*, "a herd," and also "made sacred," which is impossible. The literal translation is, *Tenei*, "here"; *tou*, "thy"; *rahui*, "herd"; *poaka*, "of pigs": or, the other sense would be, "Here thy pigs made sacred." Now, if they were under the protection of a *rahui*, would not ship and crew have been safe from harm?

## ART. VIII.—*The Railway and its Place in Social Economy.*

By A. G. PURCHAS, M.R.C.S. Eng.

[*Read before the Auckland Institute, 12th October, 1895.*]

MY aim in the following paper is to direct attention to the place which the railway should occupy in our social economy, and to the principle by which we should be guided in dealing with it. Having been familiar with the early development of railways in England up to the year 1844, and having witnessed the beginning of our own railways in this country, I now venture to state as clearly as I can certain conclusions to which I have come on this important subject.

It is hardly necessary to remind you of the origin of the railway. The renowned George Stephenson, an English working-man, whose first wages amounted to 2d. a day, was the inventor to whom the world is indebted for the locomotive engine and the construction of the first railway. On the 27th September, 1825, the Stockton and Darlington line was opened for traffic. Only seventy years have passed since that memorable day, but marvellous indeed have been the results of what was then begun. Not England only, but the whole world has felt the mighty change due to the development of the new mode of locomotion.

In that first enterprise the funds were necessarily provided by private persons, who combined together to construct the line and carry on the traffic; and they naturally and properly required those who used the railway to pay such charges as would cover all working-expenses and leave a fair margin of profit on the capital employed. And the same method of providing funds for railway work has continued to be the usual method in Great Britain and elsewhere until comparatively recent times. A large number of companies were formed,

having the necessary powers conferred on them by Acts of Parliament, and thus the railways of the country became private property, and the carrying business a large monopoly. It is true that the traffic is divided among many companies, but, so far as the people at large are concerned, the railway system is a real and irresistible monopoly, having enormous power, which has often been exercised to the serious injury of local interests. There is every reason to believe that this was, in the nature of things, at first quite unavoidable, and therefore is not to be regarded as a just occasion of blame to those courageous men by whose energy and ability, and at whose cost, the great advantages of safe and rapid transit were provided. The idea of a railway was new to the world. It could not be put to the test of practical experience without a large expenditure. It was never for a moment supposed to be within the sphere of a political government to carry out; there was therefore no alternative but to do it by private means. All that the governing power of the nation, represented by Parliament, appears to have thought it had to do was to exercise a sort of arbitrary control over what the engineers proposed. And in many instances this was so done as to cause an enormous and wholly unnecessary expenditure in parliamentary costs before a shilling could be expended in the actual making of the line. Thus it came to pass that the idea of private property in a railway was quite natural; and the consequent idea that every railway was to be looked upon as a concern wherewith to provide dividends for the owners was also perfectly natural. Of course, when we came to these new lands as immigrants we brought these old ideas with us, and it is not to be wondered at that they have proved of sufficient force to keep us from seeing how entirely inapplicable they are to any country in which railways are, as they ought always to be, the property of the people. By slow degrees a truer view of the function of railways has been perceived, and it is more and more recognised that, in this country at least, railways are and must ever be the chief highways of traffic, and therefore should be, like all other highways, free to all who require to use them. Free highways should ever be found in the country of a free people. What do the words "free highways" mean? They mean that the person who uses the highway should not have to pay toll every time he uses it; that no one should be able to say to us, "Before you walk or ride or drive or carry your goods on this road you must pay toll." Now, all this is quite plain and easy to understand when applied to an ordinary road in the country, or to a street or lane in a town; but how does it apply to a railway? I think it is not difficult to make it plain. When any one uses an ordinary road, he either walks

or provides himself with an animal or a carriage of some sort by which he may be conveyed to the place at which he wishes to arrive. It matters not whether he uses a conveyance of his own or hires one for the journey, the transit is effected at his own expense either of labour or money; but the road along which he travels is free—it has been provided for him by the officers of the State, who are appointed and provided with public funds for that special purpose. It matters not whether they are Road Boards, Town or City or County Councils, or Commissioners, or officers of the General Government, their work is public work carried out with public funds, and for the use of every individual of the community.

How, then, is it with a railway? The only difference is that which the nature of the railway traffic renders necessary. There is absolutely no difference in principle. The user must still pay for the cost of transit of himself and his goods, but the road must be free.

Railway transit, from its very nature, must always be carried on under a special system of management. The iron road cannot possibly be used in the same manner as the ordinary road. The propelling force, whether steam, electricity, or hydrocarbon, requires special engines and skilled drivers; the carriages, whether for passengers or goods, must be specially constructed; and everything connected with the traffic must be specially devised and directed in perfect order for the safety and convenience of those who use the road. For these reasons, no such private use of the road can be permitted as that which is the universal rule of the common road. It follows, therefore, that the cost of the rolling-stock and station-buildings, as well as the current expenditure of every kind necessarily incurred in carrying on the traffic, must be provided by the payments of those who use the road, and to this end such fares and rates of freight must be charged as will amply cover all such expenditure, but not more.

To put it shortly, then, there should be a complete separation in the railway accounts between the cost of forming and maintaining the line and that of the traffic over the line. The cost of the line or public highway should be paid by the owner—that is, the whole people, under the name of the State; and the cost of the traffic by the user—that is, every one who travels or has goods carried upon the line. It seems to me that when the time comes that the true idea of the railroad as the chief highway of the nation shall be generally accepted, as I think it will, there ought not to be more difficulty in carrying it out than there is now with all other highways.

It is not within the scope of this paper to discuss the question of management, but it seems to me obvious that it must necessarily be entirely independent of what is known as

political control—a species of private ownership of the worst kind—and must be intrusted to the very best and most competent experts obtainable. There is every reason to expect that the removal of the toll now exacted from every one in the high fares at present payable would result in a great increase of prosperity in the settled districts of the country, and that the opening-up and beneficial settlement of new districts by judicious railway extension would tend to lighten the burden of taxation by increasing the number of those who bear it.

I have purposely avoided any attempt to estimate the possible reduction in railway charges if the principle of payment for carriage only were adopted, but there is no doubt that it would be considerable, and would tend largely to increase the traffic, to the great benefit of the whole community.

My desire is to concentrate attention upon, and to obtain a calm and reasonable consideration of, the principle I have now endeavoured to set forth, not only by those who are now present, but by all thoughtful people throughout the country.

## Art. IX.—*Antarctic Research.*

By Major-General Schaw, C.B., R.E.

[*Read before the Wellington Philosophical Society, 31st July, 1895.*]

In the year 1887 a proposal was made to the British Government by the Government of Victoria that an expedition should be undertaken to explore the antarctic regions, at an estimated cost of £10,000, of which sum the Victorian Government guaranteed to provide £5,000 if the British Government would provide the remaining £5,000. The proposal was not favourably entertained. The objects of the expedition, as defined by the Victorian Government, were—first, the promotion of trade; and second, scientific inquiry. The Lords Commissioners of Her Majesty's Treasury stated in their reply, "The department best able to judge of the first does not think the interests involved sufficient to justify the proposed Imperial contribution; and the general result of the communications regarding the second object received from scientific bodies is to show that an expedition on the scale contemplated could do very little in the way of scientific investigation, and would have to be regarded simply as a pioneer of future more complete and costly expeditions." For these reasons they felt they would not be warranted in asking Parliament to provide the proposed contribution; and

they went on to say they "arrive at this conclusion, however, with sincere regret, and would have been glad to have co-operated with the Australian Colonies in an enterprise having something more than a merely commercial purpose. Perhaps, however, my Lords may be allowed to regard the present proposal as an indication that if any like expedition be undertaken hereafter by the Imperial Government some of the British colonies more closely interested in it might not be unwilling to contribute to its cost."

This proposed expedition, therefore, was abandoned, and the subject dropped out of notice, until it was revived by Dr. John Murray, one of the distinguished members of the late "Challenger" expedition, in a paper read by him before the Royal Geographical Society on the 27th November, 1893.

In this most valuable and exhaustive paper he related the history of antarctic explorations. He showed that Captain Cook was the first to penetrate within the antarctic circle, having reached lat. 71° 10′ S., at a point to the south-west of Patagonia, "when he probably saw the ice-barrier and the mountains beyond." This was in his second voyage, in 1774, after his circumnavigation of New Zealand in his first voyage. Since then two navigators have penetrated further south than Cook: "Weddell, in 1823, reached 74° S., but saw no land. Sir James Clark Ross, in 1841 and 1842, reached the 78th parallel, and discovered Victoria Land, south of New Zealand. No other explorers have passed beyond the 70th parallel of south latitude."

In the course of his paper Dr. Murray referred to the explorations carried out under Smith in 1819, who discovered the South Shetland Islands, and the consequent seal-fishery which sprang up, and resulted in the extermination of the seals. Bellingshausen discovered the island named Peter the Great, and Alexander the First Land; D'Urville discovered Adélie Land; the United States Exploring Expedition discovered Wilkes Land; Powell discovered the South Orkneys; Briscoe discovered Enderby's Land; Balleny discovered the Balleny Islands and Sabine Land; and Dallman, more recently, discovered Kaiser Wilhelm Islands and Bismarck Strait, to the north of Graham's Land. Dr. Murray gave unstinted praise to the good work done by these and other explorers, who, with vessels unstrengthened to resist ice, and with imperfect means, have added so much to our knowledge of antarctic regions; but he pointed out that Ross's expedition, which was better provided, and the vessels well strengthened, was, under its splendid commander, able to do more than any other; and his observations on the geology, meteorology, and magnetic phenomena of those regions, as

well as his soundings and dredgings, and observations on currents and sea-temperatures at different depths, threw a flood of new light on the physical and biological conditions within the antarctic circle; but his ships were unprovided with steam-power, like those of all other antarctic explorers; and this is extremely disadvantageous, because the vessels are unable to make progress during the all-too-scanty periods of fine, calm weather; contrary winds in ice-encumbered waters are very perplexing and dangerous, and to anchor near an ice-bound coast while exploring parties are sent ashore is too risky for sailing-vessels.

The "Challenger" is the only steam-vessel that has crossed the antarctic circle, and, as she was not strengthened to bear the blows and pressure of ice, she could do little in the way of exploration through the pack, and was obliged to confine the observations to deep-sea soundings.

Putting together all the various results of the observations that have been made, Dr. Murray has prepared various maps of the southern pole (partially reproduced), in which he has shown what parts of the coast-line of antarctic land have been fixed, and these he has connected by dotted lines indicating the probable shape of the great antarctic continent which, from all indications, he presumes to exist, surrounding the south pole, about 3,500 miles long by 1,500 miles broad, and covered with perpetual snow and ice. He indicates also the approximate position assigned to the magnetic pole or poles, and the known and supposititious mean barometric pressures—the lowest (28·9in.) being in February, off Victoria Land, near Mounts Erebus and Terror. From the observed preponderance of southerly winds he assumes that a region of high barometric pressure exists around the South Pole.

The depths of the ocean, as far as they are known, are also figured, and in his paper he draws attention to the remarkable fact that the temperature at the bottom, even at the depth of over 2,000 fathoms, is not below 33° Fahr., while at the surface it may fall to 29°, and at an intermediate depth may be as high as 40°. The abundance of life now existing in these Antarctic-Ocean depths is very notable, and specimens of fossils, apparently of Tertiary age, obtained on Seymour Island by a Norwegian whaler indicate that at one period of the world's history a more genial climate must have prevailed in those regions.

Dr. Murray's maps further give the oceanic deposits in the different areas of the south polar seas; the ice-limits and currents; the mean temperatures or isotherms, and the isobars and winds, for February; the annual mean rainfall; and the magnetic phenomena (after Neumayer).

Owing to the snowcap which envelopes the great antarctic land mass, the nucleus of rock is only revealed in off-lying islands or on the faces of high and bold escarpments, or by the fragments of rock carried seawards by icebergs, and either obtained directly from them or dredged from the sea-bottom where they have been dropped by the icebergs as they melted. Thus the geology of the country is mainly concealed from view; but the outlines and larger features of the mountain-ranges are not obliterated in the high lands near the coasts, for peak after peak with varied contours are seen to rise one behind another towards the interior. The snow which accumulates on those mountain-ranges in Victoria Land forms a vast glacier, which moves continually outwards, and presents on the coast-line a solid perpendicular wall of ice, probably from 1,200ft. to 1,500ft. in thickness, of which 150ft. to 200ft. is above the surface of the water and 1,100ft. to 1,400ft. below. When the front of this great glacier reaches depths of 300 to 400 fathoms large stretches break off and float away, forming the perpendicular-faced, horizontally-stratified, table-topped icebergs of the Antarctic and Southern Oceans. Fragments broken from these great ice-islands by collisions, mixed with salt-water ice, and accumulations of snow, form what is known as the "pack," which at favourable times and places can be penetrated by properly-protected vessels; but the great ice-wall, along which Ross coasted for three hundred miles east and west, is an absolute barrier to ships, although there are places where a landing might be effected and a winter station be formed, and one such place was noted by Ross, near Mount Erebus, and within a comparatively short distance of the magnetic pole, or where we have reason for supposing that pole to be.

Dr. Murray refers to the results of the deep-sea dredging carried out by the "Challenger" expedition, and states, "All over the floor of the Antarctic Ocean there is a most abundant fauna, apparently more abundant than in any other region of the ocean's bed. In one haul made by the "Challenger," in a depth of two miles, in lat. 47° S., the trawl brought up (excluding Protozoa) over two hundred specimens belonging to eighty-nine species of animals, of which seventy-three were new to science, including representatives of twenty-eight new genera." He says, "It is most probable—indeed, almost certain—that the floor of the ocean as well as all pelagic waters have been peopled from the shallow waters surrounding continental land, and here in the deep waters of the Antarctic we appear to have very clear indications of the existence of the descendants of animals that once inhabited the shallow waters along the shores of Antarctica, while in other regions of the ocean the descendants of the shallow-

water organisms of the northern continents prevail. This is a subject of great interest to all biologists, and can best be studied by a more efficient exploration of these southern latitudes."

The objects for which a renewed effort to explore the unknown regions in the vicinity of the southern pole should now be undertaken were summarised by Dr. John Murray as follows :—

"To determine the nature and extent of the Antarctic Continent; to penetrate into the interior; to ascertain the depth and nature of the ice-cap; to observe the character of the underlying rocks and their fossils; to take magnetical and meteorological observations, both at sea and on land; to observe the temperature of the ocean at all depths and seasons of the year; to take pendulum observations on land, and possibly also to make gravity observations at great depths in the ocean; to bore through the deposits on the floor of the ocean at certain points to ascertain the condition of the deeper layers*; to sound, trawl, and dredge, and study the character of marine organisms—all this would be the work of a modern antarctic expedition. For the more definite determination of the distribution of land and water on our planet; for the solution of many problems concerning the Ice Age; for the better determination of the internal constitution and superficial form of the earth; for a more complete knowledge of the laws which govern the motions of the atmosphere and the hydrosphere; for more trustworthy indications as to the origin of terrestrial and marine plants and animals—all these observations are earnestly demanded by the science of our day."

Dr. Murray's paper was fully discussed, and in a most favourable manner. All agreed that there was no probability of any commercial advantages resulting from antarctic explorations in the way of seal-hunting or whaling; but that the scientific knowledge to be gained would be of the very greatest value. The words of the President in summing up the discussion embody the feelings of the Council and members of the Royal Geographical Society. He said,—

"I consider that Dr. Murray's paper, and the important discussion which has followed it, will form a new starting-point in the advocacy of a renewal of antarctic discovery. We must not forget the valuable work that was done by Admiral Sir Erasmus Ommaney and the committee of the British Association five years ago. Sir Erasmus enlisted the

* "Dr. Murray believes that gravity determinations might be made, as well as the deposits bored into by specially-constructed instruments let down to the bottom from the ships."

sympathies of the Royal Society, and even of the more enlightened members of the late Government. We owe him our warmest thanks for his exertions. Nor must we forget the zealous labours of Baron von Mueller, Captain Pascoe, and our other friends in Australia. They have long worked for the good cause of antarctic discovery, and I am confident that they will continue to exert all their influence in its favour. Our illustrious gold-medallist, Baron Nordenskiöld, the discoverer of the North-east Passage, has but now written me a cheery and encouraging letter, from which the following is an extract: 'We shall follow the proceedings of an English expedition to those regions with the utmost interest, and with our best wishes for its success. It seems to me that the most important geographical problem for the moment is a systematic exploration of the hydrographic, meteorological, geological, and biological conditions of the antarctic regions. The arctic regions are in this respect now tolerably well known; but almost every scientific result gained from thence has given rise to new problems of the utmost importance for the better knowledge of our globe, which can only be satisfactorily answered by corresponding discoveries in the far south.'

"These inspiriting words will cheer us on in our task—a task from which I for one will never swerve until it is completed. I have pleasure in announcing to you that our Council has this day appointed a committee for the purpose of reporting on the best means of achieving the objects of antarctic exploration. The whole question will be thoroughly examined and discussed, and it will be our business to convince the Press and the public of its importance. We are, of course, devoted to geographical research and to the interests of science, and we look upon these objects as a chief reason for despatching an expedition. But, as an Englishman, I feel that the great result of all will be the encouragement of that spirit of maritime enterprise which has ever distinguished the people of this country, and the keeping-alive of our glorious naval traditions. We are well assured that as soon as the country is with us in the advisability of despatching an antarctic expedition the Government will concur. We may therefore work on full of confidence and hope. We shall look on this evening as our starting-point. Dr. Murray has given us the route—he has done so in a way we shall not soon forget; and I speak the sentiments of every one present in this great assembly when I offer to him our most sincere and hearty thanks for his very able and important address."

The Antarctic Committee above alluded to reported that "the importance of antarctic research, and the desirability of its renewal, are recognised by all scientific bodies at Home and

abroad"; that "one of the most important requirements is the taking of magnetic observations, as it is known that a considerable change has occurred in the magnetism of the earth during the last fifty years, and the exact position of the south magnetic pole is hardly even approximately ascertained." "Other objects of an antarctic expedition would be deep-sea soundings, the temperature of the ocean at all depths, dredgings, the study of the character and distribution of marine organisms, meteorology, and pendulum observations, if considered necessary; to explore the land as far as possible; to determine the limits of freezing in antarctic regions in the summer, and the direction of winds and currents, and the consequent formation and movements of the pack ice."

They observed that our knowledge is still very incomplete of the antarctic winds and currents. South of 40° S. there is very low atmospheric pressure, with strong westerly winds and a large rainfall and snowfall, all round the globe. Such observations as we possess show that the winds in higher southern latitudes are, on the contrary, generally from the south and south-east, and the surface-currents are in the same direction, so that in the summer the pack and the bergs are continually drifted northwards. They showed the immense advantages which steamers would have over sailing-vessels in these investigations, and gave their opinion that the operations should be carried out by the Royal Navy in two vessels as well strengthened as were the "Erebus" and "Terror," fitted with steam-power, and specially protected aft to guard the rudder and propeller.

The Royal Society, to whom the subject was referred, also appointed a special Antarctic Committee, who reported strongly in favour of an exploring expedition.

With regard to pendulum experiments, which were recommended (with reserve) by the Royal Geographical Society, but not directly alluded to by the Royal Society, it is to be observed that they were recommended by Dr. Murray; and in an appendix to his paper appears a communication from Dr. Neumayer, of the Hamburg Naval Observatory, who, after showing how exceedingly important are an examination and a survey of the magnetic properties of the antarctic region, goes on to note that the determination of the constant of gravity has never been carried out in that region, and but a very small number of determinations have been made even in the Southern Hemisphere south of lat. 33°. He gives a table containing all that is known with respect to this important question within the assigned region. To this table I have added the value of gravity corresponding with the lengths of the seconds-pendulum, as given in his table, and a few comparative values in the Northern Hemisphere:—

| | | tres. | Deg. min. | ot nds |
|---|---|---|---|---|
| Valparais | | 3568 | 33 2·5 | . |
| Paramatt .. | [illegible] | 3568 | 33 48·7 | . |
| Port Jack .. | 2625 | 3625 | 33 57·6 | . |
| Cape of Good Hope | 2580 | 3673 | 33 56 | .40 |
| Montevideo .. | 2641 | 3551 | 34 54·4 | . |
| Melbourne .. | [illegible] | 3561 | 37 49·9 | .42 |
| Kerguelen Island | | 3562 | 49 8·9 | .74 |
| Auckland Island . | [illegible] | 3490 | 50 52 | 78 |
| Falkland Island (No. 1 | 4154 | 3558 | 51 31·7 | .82' |
| Falkland Island (No. 2 | 4077 | 3476 | 51 35·3 | .78' |
| South Georgia . | 4[illegible]8 | 3608 | 54 31 | 91 |
| Staaten Island | 4[illegible]1 | 3619 | 54 46·4 | 93 |
| Cape Horn | 4565 | 3590 | 55 51·3 | [illegible] |
| South Shetlands . | 5176 | 3631 | 62 56·2 | 32·2 |

| | Dg. min. sec. | |
|---|---|---|
| ·1558 | 38 54 0 | Washington, U.S.A |
| ·183 | 48 50 0 | Paris. |
| ·191 | 51 29 | Gree |
| ·196 | 53 21 0 | Dublin. |
| ·199 | 54 36 0 | Belfast. |
| ·204 | 55 27 0 | Edinbu |
| ·206 | 57 9 0 | Aberdee |
| ·217 | 60 45 0 | Unst, N Shetlands. |
| ·221 | 62 45 0 | |
| ·2364 | 70 40 0 | Ham fest Norway. |
| ·253 | 79 49 54 | Spit |

Dr. Neumayer goes on to say that, "as far as present evidence goes, there is an accordance of facts between the Northern and Southern Hemispheres with regard to the gravity determinations; but we must not forget that from within the

south polar circle not a single determination has been consulted, because there are none." The accordance of gravity determinations obtained in the two hemispheres alluded to above has reference to the third column of the table, in which the length of the seconds-pendulum for each place, obtained by experiment, is used to calculate what should be the length of a seconds-pendulum in lat. 45° on the assumption that the earth is an ellipsoid of which the equatorial radius is 3962·802 miles and the polar radius is 3949·555 miles, and that the centre of gravity is at the centre of form. The values so obtained do not differ widely, and give a mean of 0·993577 metres—not far different from the computed length for 45°, nor from the ascertained length at Kerguelen, lat. 49° 8′ 9″. But it will be observed that there is a very notable difference in the values of G. at about the same latitudes in the two hemispheres, the force of gravity being greater in the Northern than in the Southern Hemisphere.

A comparison of the values in the two Shetlands, North and South, however, is the last that is at present available towards the poles, and it therefore appears of great scientific interest that further pendulum experiments should be made within the antarctic circle to determine the law of diminution of the force of gravity in the Southern Hemisphere.

The present state of our knowledge leads to the belief that the centre of gravity of the earth lies about three-tenths of a mile to the north of the equator. Such a condition of unsymmetrical balance of the earth, if it be established as a fact, may enable us to account for that slow gyration of the earth round an axis which is not the axis of the plane of the ecliptic, which has now been discovered to be the case; and I earnestly hope that pendulum experiments may form an integral part of the duties of the next antarctic expedition.

The centre of gravity being north of the equator, the plumb-line will be deflected there about 15″ from the true vertical, and astronomical observations by means of zenith distances will need correction. This additional means of measurement of the position of the centre of the earth's mass will, no doubt, be resorted to, so that astronomical observations may check those made by the pendulum.

The papers connected with the subject of a renewal of antarctic research have been forwarded by the President of the Royal Geographical Society to Sir James Hector for the consideration of the Council of the New Zealand Institute, with the expressed hope that they will use their influence with the New Zealand Government to give favourable consideration to the letters which have been addressed to their Agent-General by the Royal Geographical Society, and referring to

the Treasury letter previously quoted, in which the co-operation of the colonies interested was suggested.

Such co-operation, in the form of a small grant from each of the Australasian Colonies, would, it is believed, have such weight with the Imperial Government as to induce them to undertake the work at once; while the cordial feeling between the Mother-country and the colonies would be strengthened. The trade-routes between them would also be rendered safer by the increased knowledge of magnetic variations to be obtained.

The Council cordially welcomed the proposal, and I was requested to put before the members of the Wellington Philosophical Society a *précis* of the communications from the Royal Geographical Society, which I have endeavoured to do in this paper.

## ART. X.—*A Wellington Weather Prognostic.*

By Major-General SCHAW, C.B., R.E.

[*Read before the Wellington Philosophical Society, 18th December, 1895.*]

THE weather is a subject which interests us all, and any help towards guessing correctly what sort of weather we may expect within the next twelve hours or so is valuable. I say "guessing" because no weather forecasts are infallible, even when aided by all that science and long observation have enabled us as yet to attain to. Observations of the fluctuations of the barometer, and of the winds and weather experienced at a number of distant points, collected at a central office by means of the telegraph, do enable a competent person to predict with a great measure of certainty the character of weather to be expected in the immediate future; but the chain of causes influencing weather is so complicated and so far-reaching that in the existing state of our knowledge certain prediction cannot be insured—only great probability; we know how great the probability is by comparing the daily forecasts made by Captain Edwin with the actual weather which follows; and I think we must all acknowledge that his forecasts are very generally right, although not always right.

What I wish to bring before this meeting is a prognostic which every one can observe, and which, since I first observed the sign, about two years ago, has hardly ever failed to be followed very shortly by a northerly blow and rain. I mean a peculiar form of clouds. I call them "fish" clouds; but probably "mushroom-shaped" or "lenticular" clouds would

be more correct, as, although these clouds, as seen generally rather low down in the eastern sky, seem like fishes with smooth hog backs, yet no doubt they would present somewhat the same appearance if viewed sideways from any other point.

The peculiarity of these clouds is that they are very smooth and regular in their upper curved surfaces, and comparatively flat below—quite different from the bubbling surface of a cumulus cloud, or from the straightly-drawn-out forms of stratus clouds, and also widely differing from the delicate feathery forms of the high cirrus clouds.

The fish clouds belong to the class cirrostratus generally, and I should estimate that their normal level is at least 10,000ft. above the sea. Generally, the barometer is high when they begin to appear. It then begins to fall, and a northerly blow follows, sometimes within six hours, more generally after about twelve hours; but occasionally it is delayed for twenty-four hours, or even more.

The appearance of these fish clouds may be that of small, delicately-shaped, scattered fishes, in which case the following north wind is generally not strong, and there is little or no rain. If the fish-clouds be more massive, or if, as often happens, they are joined together so as to form undulating, eel-shaped clouds, with the characteristic smooth, hard, curved outline above, then probably the northerly blow will be strong, with rain. Sometimes the fish clouds are superimposed one on another, so as to form, as it were, a pile or piles of fishes. This form is not so common, but I think it also is followed by bad weather.

So far I have merely dealt with observed facts, which I hope others will also observe, if they have not done so already; and it will be specially valuable to have instances when northerly blows with rain have not been preceded by fish clouds, or when fish clouds have not been followed by the wind or rain. But, admitting that my observations are correct, and that this form of cloud usually is seen before a strong northerly wind, can we in any way account for it? We know that the great system of circulation in our atmosphere, produced by the joint action of the sun's heat and the daily rotation of the earth, gives rise to vast eddies in the air, known as cyclones and anticyclones—the cyclones, or "lows," if viewed from above, being like great saucers, rotating in this hemisphere as the hands of a watch; the anticyclones, or "highs," like inverted saucers, rotating the other way. But it is with the cyclones, or "lows," we are now concerned, as they give us our strong winds and storms. The motion of the air in a cyclone is very complicated: it is drawn inwards below, it is poured outwards above, it ascends in a spiral course,

and the whole system, extending, it may be, over one thousand or even two thousand miles of the earth's surface every way, is moving rapidly to the eastward. The rate of eastward progress averages about five hundred miles in the twenty-four hours. This causes the variations in the direction of the wind and in the height of the barometer. But the force of the wind varies with the rotary motion. The wind at the front of a cyclone approaching us from the west must be from the northward or north-westward if, as is almost always the case, the centre of the storm is not to the north of us. Very generally it is south of New Zealand altogether. Very rarely it is north of Wellington, and in these rare cases, when the storm would begin with a north-east wind, changing by east to south, probably the characteristic fish clouds would not appear.

For I imagine that their history is somewhat like this: As the cyclone advances from the west, warm, moist air is drawn in below from the north on that side of the eddy; it is whirled onward, upward, and southward until it reaches a cold level, where its water-vapour is condensed into clouds, and the dry air pouring over them smooths down their upper surfaces into the fish-back forms which we observe.

This seems to me a probable explanation of the way in which these clouds are formed on the north-eastern edge of an advancing cyclone here, and of the reason why their appearance should be a usual precursor of a north-westerly blow with a falling barometer, to be succeeded by a southerly blow with a rising barometer, as usually happens. The cause I have assigned is, of course, conjectural, but it seems to me reasonable; and, if it be true, the same weather prognostic ought, I think, to be true all up the west coast of this Island, and probably as far as Westport on the west coast of the South Island, or even farther south. On the east coast, or inland, probably this form of cloud would not be so usual or characteristic, as the advancing cyclone circulation is, as we know, much broken up by the great mountain barrier running nearly north and south through these Islands, and the indraught of air would be modified by the land-surface over which it must pass. The break in this barrier at Cook Strait and the direction of our coast-line here are undoubtedly the causes of the prevailing northerly or southerly winds experienced here, the westerly winds being deflected north or south, and easterly winds very rarely occurring, because, as before observed, the centres of the cyclones usually are to the south of us.

## Art. XI.—*The Ultimate Problem of Philosophy.*

By William W. Carlile.

[*Read before the Wellington Philosophical Society, 21st August, 1895.*]

With regard to all the great problems that in previous ages had occupied more than any others the intellect of mankind, we have become accustomed of late years in England to be told that what is golden is silence. Since the days of Berkley, for several generations speculation in regard to first principles was practically banned among us, as far as the systematic work of science and philosophy was concerned; and, looking back on that period, we are forced to inquire, Was the result from any point of view satisfactory? The outcome was that what was best in English thought took flight from the universities and found refuge in the poetry of Wordsworth, and subsequently in that of Tennyson, Browning, and Arnold; while speculation in regard to historical, political, and social questions was only saved from shallowness and triviality by the influence of German literature, reflected in the writings of Thomas Carlyle. Galileo is reported to have said that for one hour of his life that he had spent on mathematics he had spent seven on philosophy; and it seems to be the case that, somehow or other, the world is so constructed that inquiries into matters that seem at first sight wide enough from immediate practical requirements—investigations into the nature of identity and causality, of the human soul, and of the genesis of the world—are capable of putting thought on the right track even with regard to subjects of scientific detail. How otherwise can we account for the fact that Leibnitz deduced from first principles a doctrine that closely resembles the doctrine of the conservation of energy some two hundred years before its time, and the same great thinker, in his theory of the continuous gradation of created beings, arrived at conclusions that approximate to the modern doctrine of evolution?

A notable change, however, has taken place in the trend of English thought in reference to such matters during the last five-and-twenty years. Hegel, who, while the influence of his philosophy was at its zenith in Germany, was apparently, for the most part, regarded as a more or less fantastical mystic among ourselves, then began to number among his disciples and expositors many of the most competent of English philosophers, including such men as the late Mr. Green; Professor Edward Caird, the present master of Balliol; Mr. F. H. Bradley; Professors Wallace, of Oxford; Jones, of Glasgow; Wat-

son, of Canada; and many others. So much so that, if any system of philosophy can be said to be dominant in England at present, it is the system of Hegel. Hegelianism, however, is with us a general name for the philosophy which at the beginning of the century sprang up in Germany, contemporaneously with the development of the poetic spirit that gave birth to Goethe and Schiller—and was, indeed, another aspect of the same movement—rather than for the special characters which distinguish the philosophy of Hegel from that of his contemporaries Schelling and Fichte. It has been remarked, indeed, with some truth, that Hegelianism, having lost its birthright in Germany, is sojourning now in the tents of England and America. What is true and valuable in Hegelianism, however, still survives in Germany in the systems of other thinkers, even of one so widely removed from his special standpoint as Lotze, and yet more notably in the system of Von Hartman.

It is not now my intention to-night to attempt to add to the number of his expositors, or to deal with any of the details of his system. What it seems to me is the imperishable truth it contains lies in its emphatic repudiation of the right of Kant or any one else to set bounds in advance to the subjects of human inquiry, and the confident assertion of the adequacy of the grounds that we possess for the belief that behind the developments of nature and history are visible the operations of a guiding intelligence, of which our own is the offshoot and the image.

For those who incline to the opinion that mind can be adequately accounted for as something that exists in the universe only as a product of cerebral organization, a class of phenomena which manifest themselves as the result of the operations of the collective and continuous thought of a race or a community are worthy of due consideration. Take such a phenomenon as the British Constitution: We have in it a well-defined, fully-organized system, capable of being adopted by other States besides the State which originally developed it, and, in essential matters, by no means easy to improve upon. The founders of the American Republic, sharing the fancy prevalent in those days that innovation could not be other than improvement, thought that they could alter it easily for the better by separating the legislative from the executive functions. How profound was their mistake has been very conclusively made out by Mr. Bagehot. We find according to that writer that European States which have since had to adopt Constitutions have adhered much more closely to the English model than the American Convention did. If we ask, however, to what English lawgiver, statesman, or philosopher the salient characteristics of the English

Constitution are due we find at once that we might as well ask to which of the primeval men were due the first germs of the moral faculty. The separation of the legislative and executive functions, subsequently carried out with such manifold disastrous results in America, was the favourite project of reform in England at the period of the revolution of 1688, and only escaped being carried into effect owing to circumstances that present the appearance of being accidental. We see only the impulse towards freedom and self-government pervading many generations of Englishmen, and the apparently chance survival of expedients that fell in with the aim of this impulse.

A phenomenon of the same sort is the growth of Gothic architecture. "No one," as Emerson says, "can walk in a road cut through the pine-woods without being struck with the architectural appearance of the grove, especially in winter, when the barrenness of all other trees shows the low arch of the Saxons. . . . Nor can any lover of nature enter the old piles of Oxford and the English cathedrals without feeling that the forest overpowered the mind of the builder." Yet, if we turn to the history of architecture, we find apparently no one architect who had the design consciously in view of reproducing in stone the image of the forest. We can trace, on the contrary, the various stages by which the basilica became transformed into the cathedral, and can only interpret the ideal that fully realised itself in the fourteenth century as one that more or less unconsciously dominated the mind of many generations. The collective continuous mind thus seems to have in it something that cannot be accounted for offhand as the mere sum of the conscious thoughts and wishes of various individual minds.

If we glance at a widely-different department of life from the politics and art of man, other illustrations, perhaps even more interesting and more marvellous, present themselves. When Mr. Darwin writes of sexual selection there are plainly two very distinct principles before his mind. One is the survival of the strongest or best-armed males in their struggle for the possession of the females: this involves no presupposition essentially different from that involved in natural selection. The other, that to which the continuous increase in the beauty of the bird-world is due, does involve a presupposition, the full purport of which Mr. Darwin himself does not appear to have clearly realised. He thinks it sufficient to assume that the hens appreciate beautiful forms and colours to account for the fact that the cocks of many species become from generation to generation more and more beautiful. This indefinite increase in some abstract characteristic called "beauty," however, does not at all adequately represent the facts in individual instances. The "more and more" that

is spoken of can hardly be otherwise regarded than as an approximation towards something in the nature of an ideal existing in some mind that did not itself cease to exist with the passing-away of any single generation. How otherwise can we represent to ourselves the gradual evolution of the ocelli on the peacock's tail, or the still more wonderful ocelli which with such incredible accuracy reproduce the effect of light shining on a convex surface on the wing-feathers of the argus-pheasant? In the difference between the upper and lower ocellus in his illustration ("Descent of Man," p. 149, vol. ii.) we seem to see the very last finishing-touch being given to the picture. We need hardly, however, resort to isolated and remarkable instances like this to discover the operations of a general mind underlying the operations of individual minds in the lower world. It seems to gleam through every instance of the exercise of an untaught instinct. The mere fact of the discrimination by birds of the pitch of musical notes and the varieties of colour, though so obvious and familiar, if rightly considered, brings us vividly in view of the supernatural in nature. We know that the relations between notes and between colours both rest on exact numerical relations between vibrations and undulations, and that when we discriminate notes and colours we may be said, in a fashion, to perceive these numerical relations; we know that the discovery of them is, at any rate, implicit in our immediate perception, and waits only for reasoning thought to make it explicit. If the birds have, in this respect, the same perceptions that we have, can we interpret the fact otherwise than by the hypothesis that we and they alike share in the operations of a vaster mind?

We are accustomed to view all the organized and systematized products of human intelligence under the category of "things made," often with much inaccuracy. If a man builds a house or constructs a machine he has a plan, either on paper or in his mind, which he follows out in detail. The mental process as the result of which a poem is written is widely different. Burns tells us that he composed his songs often by humming an air to himself and waiting till the words came. If one could have viewed the process from the outside, without knowing anything of the mind behind it, it might have seemed to him as if there were a struggle for existence between the words, and the survival of those best fitted to meet the exigencies of the rhythm and at the same time to call up ideas that were interesting and inspiriting. The Herbartian psychology has familiarised us with the conception of a contest between ideas for a place in consciousness, and the survival of such only as fall in with the needs of a dominant apperceptive system. Survival of its constituent factors under the influence

of an ideal is indeed applicable to the genesis of all that is organized or constructed by us, even to those things that we ordinarily look upon as being made offhand in accordance with a copy. It is only the last stage that is thus accomplished. One can set himself nowadays to construct a triple-expansion engine, and need no other equipment for his task than care and patience and ordinary intelligence. But could any one have done it fifty years ago? The steps in engine-construction between that day and this have been achieved by a mental process analogous to that by which poems are written and Constitutions are developed. We are becoming daily more and more fully conscious of this fact. We can perceive that though Brunel could not build a "Great Eastern" that would work, the progress of naval construction since his time renders it probable that our descendants will build vessels of vastly greater magnitude than it. We do not set ourselves now to make wings and, having made them, leap into space, but we are still further from laying it down as beyond question that aerial navigation is for ever impossible. Rather we set ourselves to estimate what progress has been made over a period of ten or twenty years past in diminishing the proportion which the weight of engines must bear to the motor-power that they can develope, and on this basis to calculate what progress the next ten or twenty years are likely to see made in the direction of the solution of our problem. Similarly, in matters political, we have travelled far since the days when Locke or Rousseau saw in the relation between king and people the result of some conscious bargain deliberately "made" at the dawn of history; or since the days when the sages of the Directory had religions in their pigeon-holes, ready to be made actual by an edict from head-quarters. Even socialism—at any rate Fabian socialism—recognises now that it must reckon more or less with nature and its gradual processes. We are beginning to find out that there are many things in the world that are organized and systematized yet which cannot be said to be "made." "Making" is a deductive process only: it gives effect in the real world to an abstract rule. The process by which the rule itself has been obtained belongs also to thought, but to the province of induction. It is induction that we find taking place whenever the evolution of anything is the result.

A theory of the reason that would adequately define the separate provinces of induction and deduction is still a desideratum in logic. Mr. Mill's theory is by no means consistent with itself. In the body of his work he treats the two as co-ordinate processes, which achieve the same end by different means. In the chapter on "Deduction," on the contrary, we find him maintaining that every deduction has in it three stages

—an induction, a ratiocination, and a verification. That is the true account, I think, of every process of conscious reasoning. We can only draw a line that will afford the basis for consistent treatment between induction and deduction by regarding the former, substantially as Whewell does, as "the light that goes up"—the happy thought, the illuminating generalisation to which no methods are applicable; and the latter as the process by which such generalisations are in the end either confirmed or rejected. The so-called inductive methods can be applicable only to ratiocination and the verification. This view corresponds with Mr. Mill's own description, in the earlier part of his work, of reasoning from particulars to generals as the process of mother-wit of the shrewd, untaught intelligence. It may be possible thus to see some truth in the striking thought of Emerson: "Generalisation is always a new influx of divinity into the mind—hence the thrill that attends." The deductive process of "making" could, then, very plainly be only the process of human minds, whose workings are based on abstraction; and it seems, moreover, that it only corresponds to one aspect even of their processes, and that not a universal one. It may thus, I think, yet become possible for us to comprehend that, though we must give up the conception of "making" as applicable to the genesis of the world, we may still hold to the belief that it is the work of mind, and even of that description of mind of which our own is an imperfect image.

The philosophy of Hegel has familiarised us with the thought of pairs of complementary conceptions, one of which is and must be implicit in the other—though those who are loudest in affirming either of the two are often farthest from recognising that they at the same time affirm its complement. "People have only to know what they say," as he observes, "in order to find the infinite in the finite." The category of complementary conceptions is applicable to many others besides those of the infinite and the finite. The conception, for example, of the possible illusoriness of vision, of which Hume made so much use, plainly postulated the possession by us of some trustworthy standard by comparison with which the information that vision gave us might be pronounced either illusory or valid; yet with the recognition of this fact his theory of subjective idealism must necessarily have vanished. In the history of the world, indeed, as we find it, it often takes many generations for a thought that is there already as implicit to become explicit. Hence it is the rule rather than the exception with intellectual movements that they stop short at a stage that seems to us, on looking back at them, to be very obviously only an intermediate one. One wonders how, in the sixteenth century, the assertion of

the right of private judgment stopped short at the precise point that it did; and how, in the eighteenth, the *Eclaircissement*, in the main hostile to Christianity, identified itself with what is, in truth, a Christian doctrine—the equal rights of all men.

Applying this point of view to theories of the nature and genesis of the world, it seems, on reflection, sufficiently manifest that the conception of it as a mechanical system is a complementary one to the belief in the existence of a mechanician outside it. Yet the philosophies which most vehemently assert the necessary invalidity of the belief in a God who made the world as a man makes a watch are those which, with equal assurance, assert the possibility of our remaining satisfied with the conception of the world as a watch, but without any maker. Such a standpoint, however, can be only a transitional one. If there is no mechanician, then the world, it is plain, is something very different from a mechanical system. "The brain secretes thought," we are told, "as the liver secretes bile." Let us suppose that it does: the question next arises, How does the liver secrete bile? It plainly will not do to conceive of it as secreting it in anything like the same way or manner as that in which the steam-engine converts heat into motion. It must be conceived of rather as secreting it in the manner in which the engine, *plus* the man endowed with conscious will and intelligence who attends it, effects this end. If there be nothing to take the place of the man alongside the organism, then the organism itself cannot be viewed except in one of two ways—either as something that has an independent life of its own, or as something that shares the life of some wider existence.

We speak freely of some things in the world as "living," and of others as "dead" and "inert"; but if we force ourselves to consider what it is we really say when we use such expressions we will find that we can never combine the predicates of "deadness" and "inertia" with the predicates of motion and change as applicable to any subject without having in the background of our minds the thought of some cause outside such a subject that moves and changes it. Once convince us fully that no such cause exists, and its motion becomes at once for us sufficient evidence of its life. If there were nothing in the universe, we are told, but two drops of water, and they were millions of miles apart, they would not rest where they are, but would at once begin to move in a straight line towards each other. We can conceive of such a fact under the category of mechanism only, because in the semiconscious background of our minds there is the traditional thought of a God who moves them. Blot out that thought completely and the drops of water become at once

things endowed not only with some sort of life, but also with some sort of unconscious knowledge of each other's existence and position. We have been accustomed in the past to make use of the categories of the material world to express, as best we can, the facts of mind. A tendency, however, is noticeable in recent science to reverse the process. We speak naturally now of the refracted light-ray as seeking the least circuitous route to its goal that is in the circumstances possible to it. It comes naturally, too, to Mr. Darwin to ask, with reference to a reversion like the occasional appearance of the double uterus, how could it "know," as it were, what course it had to follow, unless we assume its connection by descent with some form in which it was normal.

Hence, even if we are old-fashioned enough to be desirous of finding adequate reasons for believing intelligence to be the guiding principle of the universe, we can look on with equanimity at the Kantian criticism engaged in demolishing the ontological, cosmological, and physico-theological arguments for the being of a God. The very statement of such arguments involves the conception of two subjects—nature and God—the existence of the latter of which has to be proved from qualities perceivable in the former. Let us conceive the work to be thoroughly done, and the God of the old natural theology to be extinguished. We are left alone then with nature—with the totality of things, including ourselves, as the percipients of them all. This is, then, the one subject in the universe; and we are driven at once to ask, What are its predicates? That one of them is life is a self-evident conclusion; and that others are organic unity, and in some sense the manifestation of intelligence, are further conclusions which every fresh discovery in science emphasizes. By the time we have assimilated them, however, we find that the very fact of getting rid of the God of the old natural theology has brought us back many steps in the direction of a conception which, after all, closely approximates to the conception of God in the natural mind. So far, Hume would be with us. With the common-sense of English thought, which does not let its theories run away with it, he allows his doctrine of causation to go by the board, and does not hesitate to say that there can never be any doubt as to the being of a God—the only questions that can arise are questions in reference to his nature. It is here, indeed, that the true difficulty begins. If we can go no further in assigning predicates to the one great subject than to affirm of it life, unity, and some sort of intelligence, there is much truth in Hume's contention that our belief can never be the ground "either of any action or of any forbearance." It is plain that we can find these predicates in no other manner than by casting our glance on the world

about us, and back over its history. In doing so it will be all in vain for us to attempt to shut our eyes to the manifold miseries and bitternesses of human life. Nor does it assist us to tell us, as Hegel does, that all this exists merely that the Absolute Spirit may become conscious of himself. Rather, the heart rebels at the suggestion that human misery should have been devised for the attainment of an end that cannot be represented as either noble or unselfish. There is nothing in self-consciousness that is, in itself, admirable or attractive: as Goethe profoundly remarks, humility, the sweetest of womanly virtues, can never know anything of its own existence. It is idle, too, to tell us, in any phraseology, that evil is negation—that it is something that does not really exist. He who uses such phraseology does not alter the facts, he merely confuses for himself the connotation of such words as "reality," "existence," and "evil." Shutting our eyes to nothing, we may, however, still ask ourselves the question, Does it not, in spite of everything, seem clear that "the real tendency of things is good"? This much, at any rate, was the intense conviction of one who was even more alive than most of us are to the darker side of human things. Without prejudging the question whether it is a conclusion capable of being scientifically established, it may be said that, if it can, we cannot, I think, escape from the further conclusion that there is an ideal which the Universal Mind is endeavouring to realise in the world—that this ideal is nothing else but the amelioration of its condition.

The question, at any rate, of any belief in God which is more than a formal and unmeaning one appears to be bound up with that other question whether or not the real tendency of things is good—that is to say, whether or not there is, in spite of all fluctuations, a progress, steady on the whole, towards a higher and better state of things perceptible in mundane affairs, and whether such tendency is not the necessary outcome of the laws of life and development.

Though Hegel, in his abstract formalisation of his doctrine, places the goal of existence in the realisation of itself in consciousness by the Absolute Spirit—a conception which, whatever aspect of the truth it may present, does not in any way commend itself to human love and admiration—when he comes to show us his principle at work on the stage of the world's history, we find that what it seems to mean is that there is some intelligent principle behind human affairs, or immanent in them, which converts the fall of empires, the decadence of civilisations, the inroads of barbarism—everything, in short, that seems at first merely evil and disastrous—into the starting-point for the development of new eras, charac-

terized by greater happiness and greater liberty than those which preceded them. He treads with firm and certain step —here and there, perhaps, riding his theory of triplicities to death, as when he divides even the continents and their physical features into triads—but, on the whole, arriving at a conception of historical development which largely anticipates the conclusions that the progress of science and research has since made inevitable. Schlegel's conception of a primitive universal civilisation, from which barbarism is a retrogression, is, for example, dismissed as hardly worth considering; yet its validity was maintained by very competent thinkers until quite recently in England. Altogether, his conclusions present a remarkable parallelism with those which Mr. Bagehot, in his "Physics and Politics," bases on the established doctrine of evolution. If speculation in regard to first principles is, from a practical point of view, so valueless as many would have us believe, it is strange that metaphysics anticipated science by at least half a century with reference to a matter so fertile in practical bearings as national development. What is least formal and abstract in Hegel's line of thought is probably what will be found in the long-run to be of most permanent value. His doctrine that conceptions, as soon as they become explicit, go over into their opposites, appears to be transfixed by Lotze's criticism that conceptions never alter, though the things of the finite world pass from the sphere of one conception into that of another. If the process, too, had the absolute universality which he asserts for it, it is hard to understand how rational freedom itself could be an exception. If the alleged principle were universally valid, should we not be forced to conclude that, as soon as rational freedom itself became explicit in the world, it must pass over into irrational bondage? It is hard to see also how from the absolute equivalence of the elementary opposites—from the theory that "being" and "nothing" are the same—anything but a see-saw between these opposites could result. If the negative element is to be conquered in the end, must we not conclude that it was never from the beginning the full equivalent of the affirmative? The Eleatic doctrine, adopted by Spinoza, that evil is negation, though, if taken as it stands, it is little better than a barren paradox, is yet much nearer the truth than the doctrine of the identity or full equivalence of opposites. It is, indeed, an approximate statement of a truth that has played a great *rôle* in philosophy, and is destined, perhaps, yet to play a still greater one. If evil is not literally non-existent, it at any rate, as Spinoza very clearly recognised, carries within it a self-destructive element. If reason, as he says, even persuaded us to lie for our own advantage, or even in order to save ourselves from imminent danger, it would persuade all

men always to do the same, and then social existence would become impossible; and thus the principle of lying, if carried to its full length, destroys itself. Hence reason, he concludes, can never persuade us to lie. We have in this the germ and more than the germ of the Kantian doctrine, "Let the maxim of your conduct be that which can be made into law universal." A further consequence naturally flows from it—viz., that, in as far as any nation, any theory, or any institution contains elements of moral baseness, in so far also does it contain elements of weakness; that whatever survives in the world survives in virtue of that in it which is true and valuable. This is the kernel of the doctrine that has been preached in our day with much energy of conviction by Thomas Carlyle, and has vividly impressed the English-speaking world. Referring to the rise of Mahometanism, for example, he says, "I will allow a thing to struggle for itself in this world, with any sword or tongue or implement it has, or can lay hold of. We will let it preach, and pamphleteer, and fight, and to the uttermost bestir itself, and do, beak and claws, whatsoever is in it, very sure that it will, in the long-run, conquer nothing which does not deserve to be conquered." If the real tendency of things were not good this could not be so. As it is, "All that is right," he contends, "includes itself in this, of co-operating with the real tendency of the world." If, however, we can recognise the truth that this view of life contains, we must also recognise that the intelligence which guides the universe is working out by degrees the realisation of an ideal that is also our own.

Carlyle's doctrine is plainly a doctrine of the survival of the fittest among theories, religions, and institutions; and here again we find speculation on first principles anticipating the conclusions of science. It differs from Mr. Darwin's survival of the fittest, however, in this: that in it the "fittest" has the definite meaning of the best and the worthiest. With reference to Mr. Darwin's formula, it has frequently been pointed out that the survival of the fittest can mean only the survival of what is best adapted to survive. Like the Hegelian theory, however, it appears to more advantage in action than its formulas. When we see how it is applied we can perceive in it another meaning. Mr. Darwin himself finds in it a principle which must necessarily lead to the development of the social instincts, the unselfish side of our nature. It seems clear to him, too, both that the struggle for existence cannot fail to develope intellect in the race, and also that the development of intellect must secure the development of morality *pari passu* with it. We arrive thus by another *à priori* road at the same conclusion—that the real tendency of things cannot be otherwise than good.

Perhaps the greatest difficulty that presents itself to the acceptance of this conclusion is that which flows from the doctrine of the equivalence of opposites. It needs little reflection to discover that the biblical conception of the knowledge of good as having entered the world together with the knowledge of evil shadows forth a truth of wide-spreading significance. It is plain enough that the hero and the martyr could never have appeared in the world without the tyrant and the bigot. The delights of success for one man must, it always seems, bear a tolerably exact proportion to the agony of possible disappointment for himself, and of real disappointment for others similarly situated. If by what we fancy as the fiat of Omnipotence pain were at once completely done away with, we might find that the principle of consciousness, perhaps of vitality itself, had perished. We are thus sometimes driven to question the very possibility, in the nature of things, of any fuller realisation of happiness in the world than we find there now. It must be conceded, I think, that the negative principle must always be manifested there in some shape. Without the possibility of disappointment there could be no such thing as the serious pursuit of any purpose, and the possibility of disappointment itself involves pain, and pain often of the acutest sort. It may be that we are dreaming altogether idly in dreaming of a painless golden age ahead of us. This much, however, is observable: that the negative principle can assume very different forms in different stages of the world's development. In nature, the only remedy for failure or imperfection is the prompt destruction of the forms that manifest defects. When consciousness dawns, the place of destruction can be taken by the instinctive association of pain with what is injurious. With the civilised man, again, the mental representation of pain—say of starvation—some time in the future can take the place of the actual pangs of hunger in the present. A further stage sees the approval of our fellows largely substituted for every other motive of action. The worst of all pains for us, then, is to be found in the fact of being shunned and despised by our neighbours; and, at a still further stage, we can feel that even this is endurable so long as we are not forced to agree with our neighbours in detesting and despising ourselves, that being the one pain at all hazards to be avoided. If thus even we are forced to hold that pain can never be got rid of, there is ample room for the amelioration of the world in the substitution of the more refined for the grosser forms of it.

Out of such reflections on the nature of pain there dawns dimly on us the suspicion that we may be in error in the fancy that Omnipotence could make all men happy and

virtuous by its fiat if it pleased. Happiness and virtue may be things that are not "makeable." If "making" is a category applicable only to a very limited aspect of the operations of the human mind it may not be applicable at all to the operations of the Universal Mind. What if, in the nature of things, nothing better is achievable than that which has been achieved and is being achieved? We have wars still: possibly without them civilisation might fall into rottenness and decadence. They are not followed, however, nowadays by the enslavement and slaughter of unarmed populations As, moreover, the customary law in each nation, when it gained sufficient strength, in the end created a tribunal to enforce it, so it seems possible that international law, which now exists in the shape of custom only, may also similarly develope itself. We have thus, perhaps, in the very fact of the existence of international law, a prophecy of a federation of the nations strong enough to make public war as impossible between civilised States as private war is now within them.

Not many years ago we were in despair at the anticipation that the trend of our industrial civilisation was in the direction, no doubt, of making the rich richer, but at the same time of making the lot of the poor harder than ever it had been. Recent developments appear to indicate that this was only a transitional stage. It is coming to be widely believed now that the unfailing tendency of every new invention is to shorten the hours and to increase the remuneration of labour, as well as to increase the purchasing-power of its earnings. It seems on all grounds well within the bounds of possibility that the next century will see an enormous diminution in the physical miseries of the world, and it seems open to us, at any rate, to hail every achievement of science as something that is without fail hastening on that consummation. Impartial, unbiassed reasoning alone appears to be all that is requisite to warrant our faith in the beneficence of the Mind that is guiding our destinies.

# Art. XII.—*Memorabilia of certain Animal Prodigies, Native and Foreign, Ancient and Modern.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th November, 1894.*]

St. George, that swinged the *dragon*, and e'er since
Sits on his horseback at mine hostess' door,
Teach us some fence! . . .
And make a monster of you.
Shaksp., "K. John," Act II., Sc. I.

I go alone,
Like to a lonely *dragon*, that his fen
Makes fear'd, and talk'd of more than seen.
Shaksp., "Coriol.," Act IV., Sc. 1.

Early in the month of May, when the shooting season begins, I was residing, as usual in the autumn, at Dannevirke, in the Forty-mile Bush, and I heard the friendly warning given to "Look out!" or "Beware!" at a certain notorious lagoon, pool, or deep-water swamp, frequented by ducks, lying about three miles from Dannevirke, and not far from the bridge over the River Manawatu.

Curiosity being aroused, I made inquiry, and I found that during the shooting season of the last year (1893) a young man of Dannevirke named George Slade, out shooting, had there seen a *taniwha* (unknown watery monster), and had fired at it and wounded it. Through the kindness of the resident clergyman (Rev. E. Robertshawe) I had an interview next day with the young man, who related the whole matter very clearly, temperately, and coherently; and, briefly, it was as follows: He was out shooting, and, having fired at a duck there swimming, and killed it, his dog went into the water after it; but before the dog got up to the duck a large animal (unknown) emerged from the thickly-growing raupo (bulrushes) adjacent, and, swimming, made direct for the dog; on this the dog retreated howling, *sans* duck. Seeing this, Slade, on the high land above, fired at the strange animal, and struck its head, beyond the eye, and near the angle of its mouth. On receiving the shot the creature turned and swam back into the tall raupo, and was not again seen. Slade further said, its head was raised, as if on a neck, a little above the water, and appeared about 18in. long, with greyish hair or fur. He had related the occurrence at the time on his return to the township, so that it was well known and talked of. This fresh and strange relation by him brought four others to the fore, who stated that, when out riding lately in that neighbourhood, they too had seen a creature, apparently

swimming, in the water there, that looked in the distance like a young colt* with its head and neck above the surface.

The place itself is isolated, surrounded by high, broken, cliffy banks that are deeply wooded, and rather difficult of access, the water having a narrow outlet into the River Manawatu.

This newly-repeated narration of that strange event of 1893, together with the simple, honest, unpretending manner in which it was told, and the knowledge the residents had of the character of the relator, made such an impression on the minds of some of my friends who heard it, that three of them (strong and determined, and used to heavy bush-travelling) arranged to visit that out-of-the-way spot the next day, the weather, too, being fine at the time. They did so, and, after much and heavy exertion, descended the cliffs, and explored pretty much of the shores and surroundings of the lagoon, but saw nothing of any strange animal, and, after extricating themselves with some difficulty, they returned late at night to Dannevirke.

While we were conversing with Mr. Slade, I expressed my opinion that the animal seen by him in the water might be one of the seals of the New Zealand seas, which I had seen in former years on our sea-shores, and whose hair was also of that colour described by him; but how a marine mammal should have found its way so far inland, and particularly through and against the current of the rough and rapid waters of the notorious Manawatu Gorge (the only way of access), seemed an insurmountable obstacle. However, I offered him a good round sum for the animal, or for any pretty large portion of it. Mr. Robertshawe, also present, related the capture of one of those seals far up in the River Waikato several years ago.

In writing to Sir James Hector shortly afterwards (on other matters) I mentioned this phenomenon, and, in reply, Sir James says, "Your *taniwha* is no doubt *Stenorhynchus leptonyx*. Several years ago I heard the same tale from the same district, and on inquiry found it to be so. Ten years ago a *taniwha* was captured in a lagoon near Hamilton on the Waikato, and exhibited in a butcher's shop, and it proved to be a *Stenorhynchus*."

An instance of the capture of one of these marine animals I may mention, as it came under my own observation, and the circumstances attending its seizure were strange, if not unique. It happened early in the forties. I was then residing at Waitangi, on the immediate southern shore of Hawke's

* Lest this should seem strange, I mention in a note that Maori horses, half wild, are very numerous in those parts.

Bay, and close by the Maori pa (village) Awapuni. One morning there was a great outcry, and a big movement of a body of natives from the village on to the beach. I went thither to see what was the matter, and I found they had captured a large greyish-blue hairy seal, and this in a peculiar way. Some children were playing on the beach, and they saw at a little distance what they supposed to be a woman asleep on the warm and dry shingle, a short distance above high-water mark. By-and-by they went towards her, when they soon found out their mistake, and immediately raised a cry, not knowing what it was. The chief, Karaitiana,* who happened to be walking on the beach not far off, ran up and saw the big seal; and now the creature, alarmed, was scuttling away fast towards the sea. Karaitiana had nothing in his hands with which to bar its progress, while the animal, turning its head from side to side, snapped its jaws fiercely; so he threw himself down flat on the beach and grasped the seal with his two hands just above the tail and held on firmly, and, being a tall and stout man, the seal could not draw him along the beach, but in its exertions threw up stones and gravel with its flippers, and knocked Karaitiana about pretty considerably. In a little while, however, other Maoris came running up to the spot armed with axes, hatchets, and clubs, and soon put an end to the struggle, carrying off the seal in triumph to their village; and some time after, while the earth-ovens were being prepared for cooking the animal, I was astonished at seeing its jaws open and snap loudly several times, although its skull had been broken into with axes and brains protruding, the head not yet being severed from the body. I was also struck with the appearance of its large and formidable 3-cuspidate molar teeth in both jaws, which also regularly locked into each other. I obtained the head as my perquisite, and buried it in my garden *pro tem.* as a step towards preserving the bones; but long after, when I frequently sought it, after submerging floods, I never could find it.

On several occasions I have had the dried skins of these animals (taken on the outer coast, as at Waimarama, near Cape Kidnappers, and further south) brought to me for sale, but, not having any use for them, I only purchased one. They were all nearly alike in general appearance as to size, hairiness, and colour of their hair, quite dry and hard, having been carefully flayed from the animal, and stretched out and dried on a hollow frame of sticks, according to the ancient Maori manner of drying their dog and other skins. Of course, they were all captured by the Maoris when on shore.

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* Karaitiana, in after years, became an elected Maori member of the House of Representatives.

As seals are known by us to be of gregarious habits, a peculiar proverbial saying of the ancient Maoris respecting these animals may be fitly adduced here as showing their also having had some knowledge of that kind: "*Na to tamahine kapai i takina mai ai tenei kekeno ki konei*"="It was thy exceedingly pretty and willing daughter which drew this seal to land here." "This speaks for itself, and would be doubly suitable for such a chief to say coming by *sea*—along the coast: in the olden times nearly all peaceful visits were made by water." "N.B.—The verb *taki* (pass. *takina*), here used, means to forcibly draw a captured fish to land out of the water."*

To return to the *taniwha*, or *ngarara* (water-monster), or crocodile and dragon: During my long residence in this country (now considerably more than half a century) I have repeatedly heard from old Maoris of somewhat similar, though much more marvellous, occurrences; I have also been shown the lairs and "bones" (*calcite*), and the remains and signs of the wonderful doings of such monstrous creatures = *nga-taniwha* (in the big slips of earth from the hill- and mountain-sides, caused by their sudden throes and emergence from beneath or within the solid earth); but of the creatures themselves I have found nothing, not even the slightest remains.

And here, I think, I may properly call your attention to those transcendent Maori stories and legends of the olden time, in which the taking and destroying of several huge and hideous animals of the reptilian class and of the saurian (or crocodile) order by some of their valorous and skilful ancestors is graphically and clearly related. To them I would refer you, my audience, this night; I have faithfully translated them, and you will find them recorded in the Transactions of our Institute†; and I assure you they are well worthy your perusal, and in reading them it should ever be borne in mind that the Maoris firmly believed in their truth; hence, too, it was that they did not care to venture into strange, unfrequented places, from fear of those immense *ngarara* infesting them: this is nicely shown by Dieffenbach, in his quaint relation of the opposition made by the Maoris against his ascending Mount Egmont, lest he should be destroyed by the *ngararas*.‡

But, while those ancient Maori stories partake so very largely of the marvellous, and are also mere relations, orally handed down from generation to generation—

> Till their own tales at length deceive 'em,
> And oft repeating they believe 'em§

* Trans. N.Z. Inst., vol. xii, p. 144.: "Maori Proverbs," No. 207.
† Vol. xi., pp. 82–100.
‡ Dieffenbach's "New Zealand," vol. i., p. 140.
§ Prior.

—obscured in the night or twilight of the dim past there are similar and well-authenticated European narrations contained in written history. Some of them, being but little known, I purpose bringing to your notice this evening.

My first is from ancient Roman history, originally recorded by the able Latin historian Livy (though that portion of his works containing it has long been lost), and is thus related by Valerius Maximus from Livy, by whom it is said to have been recorded at greater length. It is the account of that enormous reptile which spread dismay even through a powerful and disciplined Roman army. Valerius says,—

"We may here mention the serpent so eloquently and accurately recorded by Livy, who says that near the River Bagrada, in Africa, a snake was seen of so enormous a magnitude as to prevent the army of Attilius Regulus from the use of the river; and, after snatching up several soldiers with its enormous mouth and devouring them, and killing several more by striking and squeezing them by the spine of its tail, was at length destroyed by assailing it with all the force of military engines and showers of stones, after it had withstood the attack of their spears and darts; that it was regarded by the whole army as a more formidable enemy than even Carthage itself; and that, the whole adjacent region being tainted with the pestilential effluvia proceeding from its remains, and the waters with its blood, the Roman army was obliged to move its station. He also adds that the skin of the monster, measuring 120ft. in length, was sent to Rome as a trophy." Pliny also relates this story, saying, "It is a well-known fact that during the Punic war, at the River Bagrada, a serpent 120ft. in length was taken by the Roman army under Regulus, being besieged, like a fortress, by means of balistæ and other engines of war. Its skin and jaws were preserved in a temple at Rome down to the time of the Numantine war."* That wonderful encounter took place B.C. 256.

My second narration is a much more modern one, though happening five hundred years ago. It is well and fully authenticated, and, I think, very interesting, particularly as several of its prominent features are curiously in close accord with the Maori tales; and, as I have only met with it in a valuable and scarce old folio of the last century, I have made a copious extract of it, deeming it worthy to be brought before you.

* Pliny, "Nat. Hist.," lib. viii., c. 14. This astonishing event is also referred to by many ancient writers; among others, by Florus (lib. ii., c. 2); Aulus Gellius (lib. vi., c. 3); and Val. Maximus (*supra*), (lib. i., c. 8).

In the "History of the Knights of Malta," by the Abbé Vertot, is the following relation: "In 1340 A.D. the Grand Master of the Order, Helion de Villeneuve, from charity and prudential motives, forbade all the knights, on pain of degradation, to offer to fight a serpent or crocodile. This crocodile was of monstrous size, did a vast deal of mischief in the Island of Rhodes, and had even devoured some of the inhabitants. For the better understanding so extraordinary an incident, we shall barely relate what history says on the subject.

"The haunt of this furious animal was in a cavern on the edge of a marsh at the foot of Mount St. Stephen, two miles from the city. He went often out to seek his prey. He ate sheep, cows, and sometimes horses when they came near the water and edge of the marsh; the inhabitants complained, likewise, that he had devoured some young shepherds that were keeping their flocks. Several of the bravest knights of the convent, at different times, and unknown to each other, went singly out of the city to endeavour to kill him, but none of them ever came back. As the use of firearms was not then invented, and the skin of this kind of monster was covered with scales that were proof against the keenest arrows and darts, the arms, if we may so say, were not equal, and the serpent soon despatched them. This was the motive which engaged the Grand Master to forbid the knights attempting any more an enterprise that seemed above human strength.

"They all obeyed him except one knight, of the language of Provence, named Dieu-donné de Gozon, who, in breach of this prohibition, and without being daunted at the fate of his brother companions, formed secretly the design of fighting this voracious beast, resolving to perish in it or deliver the Isle of Rhodes. This resolution is generally ascribed to the intrepid courage of the knight, though others pretend that he was likewise pushed on to it by the stinging invectives with which his courage had been insulted at Rhodes, because, having gone several times out of the city to fight the serpent, he had contented himself with taking a view of it at a distance, and had thereby employed his prudence more than his valour.

"Whatever were the motives that determined the knight to try this adventure, he, to begin the execution of his project, went into France and retired to the castle of Gozon, which is still standing, in the Province of Languedoc. Having observed that the serpent had no scales under the belly, he formed the plan of his enterprise upon that observation.

"He caused a figure of this monstrous beast to be made in wood or pasteboard, according to the idea he had preserved of it, and took particular care to imitate the colour of it. He

afterwards taught two young bulldogs to run when he cried out and throw themselves under the belly of that terrible creature, whilst he himself, mounted on horseback, clad in armour, with his lance in his hand, pretended at the same time to strike at it in several places. The knight spent several months using this exercise every day, and as soon as he found his dogs perfect in this way of fighting he returned to Rhodes. He was scarce arrived in the island when, without communicating his design to anybody whatsoever, he made his arms be carried privately near a church situated on the top of the mountain of St. Stephen, where he came attended by only two servants, whom he had brought from France. He went into the church, and, after recommending himself to God, took his arms, mounted on horseback, and ordered his servants, if he perished in the combat, to return to France, but to come up to him if they perceived he had either killed the serpent or was wounded himself. He then went down the mountain with his two dogs, advanced straight to the marsh and the haunt of the serpent, who, at the noise that he made, ran with open mouth and eyes darting fire to devour him. Gozon gave it a stroke with his lance, which the thickness and hardness of its scales made of no effect. He was preparing to redouble his stroke, but his horse, frightened with the hissing and smell of the serpent, refuses to advance, retires back, and leaps aside, and would have been the occasion of his master's destruction if he, with great presence of mind, had not thrown himself off; and then, taking his sword in hand, and attended by his two faithful dogs, he immediately comes up to the horrible beast, and gives him several strokes in different places, but the hardness of the scales hindered them from entering. The furious animal, with a stroke of his tail, threw him on the ground, and would infallibly have devoured him if his two dogs, according as they had been taught, had not seized the serpent by the belly, which they tore and mangled with their teeth, without his being able, though he struggled with all his strength, to force them to quit their hold. The knight, by the help of this succour, gets up, and, joining his two dogs, thrust his sword up to the hilt in a place that was not defended by scales; he there made a large wound, from whence a deluge of blood flowed out. The monster, wounded to death, falls upon the knight and beats him down a second time, and would have stifled him by the prodigious weight and bulk of its body if the two servants, who had been spectators of the combat, had not, seeing the serpent dead, run in to the relief of their master. They found him in a swoon and thought him dead, but when they had with great difficulty drawn him from under the serpent to give him room to breathe, in case he was alive, they took off

his helmet, and, after throwing a little water upon his face, he at last opened his eyes. The first spectacle, and the most agreeable one that could offer itself to his sight, was that of seeing his enemy slain, which was attended with the satisfaction of having succeeded in so difficult an enterprise, in which many of his brother companions had lost their lives.

"No sooner was the fame of his victory and the serpent's death proclaimed in the city but a crowd of inhabitants thronged out to meet him. The knights conducted him in triumph to the Grand Master's palace; but in the midst of their acclamations the conqueror was infinitely surprised when the Grand Master, looking on him with indignation, demanded of him if he did not know the orders he had given against attacking that dangerous beast, and if he thought they might be violated with impunity. Immediately this strict observer of discipline, without vouchsafing to hear him, or being moved in the least by the intercession of the knights, sent him directly to prison. He next convened the Council, where he represented that the Order could by no means dispense with inflicting a rigorous punishment on so notorious a disobedience, that was more prejudicial to discipline than the life of several serpents would have been to the cattle and inhabitants of that quarter of the island; and, like another Manlius, he declared his opinion was that that victory should be made fatal to the conqueror. But the Council prevailed that he should be only deprived of the habit of the Order: in short, the unfortunate knight was ignominiously degraded, and there was but a short interval between his victory and this kind of punishment, which he found more cruel and severe than death itself.

"But the Grand Master, after having by this chastisement performed the obligations due to the preservation of discipline, returned to his natural temper, which was full of sweetness and good-nature. He was pleased to be pacified, and managed things in such a manner as to make them entreat him to grant a pardon, which he would have solicited himself if he had not been at the head of the Order. At the pressing instances made him by the principal commanders, he restored him to the habit and his favour, and loaded him with kindnesses. All this was not to be compared to the unfeigned praises of the people, who dispose absolutely of glory, whilst princes, how potent soever they may be, can only have the disposal of the honours and dignities of the State.

"They set up the head of this serpent or crocodile over one of the gates of the city, as a monument of Gozon's victory. Thevenot, in the relation of his travels, says that it was there in his time—or, at least, the effigies of it; that he himself had seen it there; that it was much bigger and

larger than that of a horse, its mouth reaching from ear to ear; big teeth, large eyes, the holes of the nostrils round, and the skin of a whitish-grey—occasioned perhaps by the dust which it gathered in course of time."

Vertot goes on to remark, "We shall be less surprised at so extraordinary an incident if we reflect that the Isle of Rhodes was anciently called Ophiusa, from the Greek word ὄφις, which signifies a serpent, from the great number of those reptiles that infested that island. Hyginus, a Greek historian, relates, upon the testimony of Polyzelus, a Rhodian, that a Thessalian, son of Triopas, or of Lapithas according to Diodorus Siculus, having been thrown by a storm on the coast of Rhodes, happily exterminated those mischievous animals; that Phorbas, among the rest, killed one of them of a prodigious bigness, which devoured the inhabitants. The learned Bochart pretends that the Phœnicians called the island by the name of Gesirath-Rod—*i.e.*, "the isle of serpents"—Gesirath, according to that author, being a term common to the Phœnicians, Syrians, Arabians, and Chaldeans for signifying an island, and Rod, in the Phœnician tongue, signifying a serpent; so that, joining these two words together, they formed that of Gesirath-Rod, whence the Greeks afterwards made that of Rhodes, which the isle has preserved to this day."

Then Vertot goes on to relate "a like event which happened in Africa, while Attilius Regulus commanded the Roman army there" (given more briefly by me above); and then he remarks, "I do not maintain that there has been no exaggeration in the length of the African serpent, nor assert everything that is told of the monstrous bulk of the crocodile of Rhodes; but what appears certain from the historians of that time, from tradition, and even from inscriptions and from authentic monuments, is that Gozon killed a terrible animal, and by that means acquired a great reputation, especially with the people of Rhodes, who looked upon him as their deliverer.

"The Grand Master, to make him some amends for the mortification he had given him, conferred rich commandries upon him. He took him afterwards to be near his person, and, finding a prudence in him equal to his bravery, he made him at last his lieutenant-general in the government of the island."

About the year 1846 the Grand Master Helion de Villeneuve died, and the knights met in solemn conclave to elect his successor; and our author states, "The Commander de Gozon was one of the electors. When it came to his turn to give his voice he said, 'When I entered this conclave I made a solemn oath that I would not propose any one but such a knight as I should judge most deserving of this great dignity,

and to have the best intentions for the general good of the whole Order; and, after having seriously considered the matter, . . . I declare that I find nobody better qualified for the government of our Order than myself.' He then made a fine harangue upon his own virtues; the fight against the serpent was not forgotten, but he insisted chiefly on his conduct from the time that the Grand Master Villeneuve had made him his lieutenant"; and in the end he was elected to that high dignity, and, the historian adds, "he was solemnly acknowledged as Great Master to the satisfaction of the convent, and especially of the citizens of the Town of Rhodes and the inhabitants of the island, who, since his victory over the serpent, looked upon him as the hero of the Order."

There are several pages in this work showing how well he presided and wrought. He died suddenly in December, 1353; on which Vertot says, "If that term 'sudden' may be allowed with regard to so good a man, who had always been more watchful over his own conduct than over that of the knights under his care. His funeral was celebrated with the just eulogiums of his brother knights, and the tears of all the inhabitants of the isle, and of the poor especially, to whom he was indeed a father. All the inscription put on his tomb was this: 'Here lies the Vanquisher of the Dragon.'" (*L.c.*, vol. i., pp. 249–263.)

While engaged in writing this paper I have thought that, on hearing this clearly-written and plain statement concerning the knight Gozon and the dragon, two main thoughts or ideas were likely to arise within your minds—one, the great similarity in several circumstances between this narration and those ancient Maori stories concerning the slaying of monstrous dragons or crocodiles; and the other, the likeness and suitability of much of the relation to illustrate the old English story of "St. George and the Dragon." This tale of the patron saint of England is, perhaps, just as truthful as those Maori recitals; for it has baffled all antiquarian research—I mean with reference to his terrible fight with the monster, with which (it is just barely possible) Gozon's combat with the dragon may have had something to do by way of embellishment, as the date of the fight was during the time of the Crusades, in which, of course, the knights of Malta were largely occupied. Moreover, we are told in history how St. George came to be the patron saint of England; which I may also briefly state, as it is a kind of evidence in support of my notion just mentioned:—

"When Robert, Duke of Normandy, son to William the Conqueror, was prosecuting his victories against the Turks, and laying siege to the famous City of Antioch, which was like to be relieved by a mighty army of the Saracens, St.

George appeared with an innumerable army coming down from the hills all in white, with a red cross in his banner, to reinforce the Christians, which occasioned the infidel army to fly, and the Christians to possess themselves of the town. This story made St. George extraordinarily famous in those times, and to be esteemed a patron, not only of the English, but of Christianity itself."* Be that as it may, we of to-day are better acquainted with the well-executed effigies of St. George and the Dragon which adorn our modern British coins of crowns and sovereigns, which realities are tangible, valuable, and desirable, whatever the origin of the marvellous fight may be.

[NOTE.—The peculiar spelling, &c., are due to the age of the work whence quotations made—the middle of the eighteenth century.]

## ART. XIII.—*Democracy.*

By Rev. J. BATES.

[*Read before the Auckland Institute, 21st October, 1895.*]

"Man is born to be a citizen."

WE are being daily taught that *law* reigns everywhere, and the conviction is freeing us from many idle beliefs, and giving us "confidence in the universe." If, then, the presence of law is universal we look for it not alone in the material world, but in the sphere of man's intelligent action. Here, too, nothing happens by accident, and chance does not exist. It must be admitted, of course, that where the human will and passions are directly concerned our knowledge and theories lack the degree of precision and universality which characterizes the physical and mathematical sciences. But accurate knowledge of a kind is attainable, and some general laws can be deduced. It is claimed, therefore, that there is a *science* of politics. The term does not denote a body of infallible rules which the statesman may use for his guidance in cases of practical difficulty, but rather principles of social relations and duties. It is in virtue of this science that men are able to test and reject mischievous theories in politics. Man is a citizen—a member always of some social order. As

* Wheatly "On the Common Prayer," p. 61; who also says, "St. George, the famous patron of the English nation, was born in Cappadocia, and suffered for the sake of his religion, A.D. 290, under the Emperor Diocletian (in whose army he had before been a colonel), being supposed to have been the person that pulled down the edict against the Christians which Diocletian had caused to be affixed upon the church-doors. Subsequently he had a church dedicated to him by Justinian the Emperor."

such he will inevitably be led to "reflect on the nature of the State, the functions of government, the nature and authority of civil obligation." Nor will he stop there. He will proceed to apply the most searching and exact methods of investigation, and draw conclusions. Thus slowly but surely a science of politics is growing up, based on ever-widening knowledge, and marked by logical exactness.

It is well to remember that the science of politics is not entirely or even mainly a creation of our day. Aristotle was its real founder, and his special service was to separate politics from ethics. Since his time many of the world's foremost thinkers and teachers have laboured in the same field, amongst them being, in our own country, Hobbes, Locke, Burke, Bentham, the Mills, Herbert Spencer, and several others. Each of these has contributed something definite of his own to the elucidation of the subject, or has helped to correct mistaken notions. Wild speculation there has been, and hasty generalisations; but these have in many cases been refuted or rectified. The materials for sound political theory are accumulating. It only needs that intelligent use shall be made of these by the statesman and legislator. We may reasonably hope that the diffusion of general knowledge, and acquaintance with the methods and results of science, will gradually dispose men to make political changes with caution, and only on sufficient ground.

In politics, whether theoretical or practical, problems of the most perplexing nature present themselves, and the discussion of these reveals irreconcilable differences of opinion, and gives rise often to some bitterness of feeling. This is to be expected. Uncertainty as to the goal towards which human society is moving, and doubt as to the right road to take, would alone, even under otherwise favourable circumstances, raise questions of great difficulty. But the difficulty is vastly increased by the conflicting social ideals and aspirations of men and their defective morality. Accordingly, the history of human society is a chequered one. Man has hitherto advanced by blundering. Dearly-bought experience has taught him his errors in the sphere of politics as elsewhere. We cannot hope that the path of social progress will ever be easy to find or free of difficulties. Politics, therefore, can never be child's play.

Again, as accounting for the estrangement between citizens in regard to matters of State policy, it is to be recognised that the effects of political action are very grave and far-reaching, and profoundly concern the community, both collectively and individually. It is the duty of every man, therefore, to be on the alert, and to guard that which is essential to his welfare. All legislative proposals should be subjected

to the closest scrutiny, and discussed as fully and openly as possible. Only in this way can citizens preserve their liberty and advance socially. Now, it must happen that when men's interests are menaced, or supposed to be menaced, sides will be taken, and every effort made to defeat what are thought to be obnoxious measures. Even political theories, wild and impracticable though they may seem to be, cannot safely be ignored. They are not got rid of by simply calling them "fads." Theory has a strong tendency to translate itself into fact, and politics afford a favourable arena for the experiment.

The existence through long centuries of organized parties in the State, and the rise of new ones in more recent times, witness to wide and persistent divergence of opinion, method, and ideals in the sphere of politics. Rival policies, embodied in party organizations, are thought to be justified on the ground that they serve to correct one another by material criticism, and thus to assure progress. But the mere mention of the party names—Conservative, Liberal, Radical, Socialist, Anarchist, and the like—indicates how complicated political questions have grown, and how greatly the decision of them is embarrassed. It is difficult for any statesman or party nowadays to hold on a steady course in politics. The older political parties are failing to satisfy the demands of electors, and the old political creeds have been variously modified, and are loosely held. The rearrangement of parties and sections of parties by mutual compromise is a familiar spectacle. These and the like changes show what mighty transforming forces are at work in the body politic.

Man, it would seem, must ever be a framer of polities, impelled thereto by necessity of nature and social exigencies. The State is, in germ, involved in the very constitution of man. Endowed with social instincts, man must have fellowship with his kind. He cannot live in solitude: he must therefore enter into relations with his fellows. Man, as far as we know him, has always lived in society, and hence his actions must be brought under some regulation. In the case of civilised man, his thought is ever growing wider and clearer, his sympathies more comprehensive, his life more complex. Added to this, man has shown in all stages of his history a capacity for conceiving ideals—artistic, religious, moral, social, political—and his destiny is to devote his energies, even to lay down his life, to realise his ideals.

He has not been uniformly successful in his efforts for this realisation. At best, his steps have been slow and painful; but often he has failed, missed the way altogether, or come back to his starting-point. He has learned to do right by blundering.

On the whole, however, he has made progress. He has undoubtedly made progress in knowledge, industrial arts, and military discipline. He has improved his surroundings—made them more favourable to his self-development. The easier, ruder forms of social life must have preceded the more complex and polished forms. Modern political communities of the advanced type have been evolved out of much simpler associations of human beings. But the progress has always been partial. There has never been, nor is there now, an advance—certainly not an equal advance—of the whole race of man. As a matter of fact, we find the more advanced portions of mankind grouped in well-defined entities, called States. What does this term "State" denote? Unfortunately, the word is used somewhat loosely. It signifies sometimes the government—that is, the governing authorities, in contradistinction to the governed. Sometimes it denotes the governed as opposed to the government. A common usage makes the word stand for the secular authorities as distinguished from the ecclesiastical. Yet another usage makes the word denote the nation as a subject of government. This variable usage is the more to be regretted because the term stands for an essential conception of political science. The State may be defined as a large group of men, occupying a considerable area of the earth's surface, speaking for the most part the same language, and united under a single government. Professor Amos, in his book on the "Science of Politics," says, "The State, in the modern acceptation of the term, carries with it the ideas of territorial limitation, of population, past, present, and to come, and of organization for the purposes of government." In Canada and the United States of America we see a very extensive territory, inhabited by men of the same race and speaking the same language, who yet do not form a State because they lack political unity.

Altogether different from our conception was the Greek conception of a State. "There was in the Greek mind," says Professor Freeman, "a distinct idea of a Greek nation, united by common origin, speech, religion, and civilisation. . . . But that the whole Greek nation, or so much of it as formed a continuous or nearly continuous territory, could be united into one political community never came into the mind of any Greek statesman or Greek philosopher. The independence of each city was the one cardinal principle from which all Greek political life started. The State, the commonwealth, was in Greek eyes a city, an organized society of men dwelling in a walled town as the hearth and home of the political society, and with a surrounding territory not too large to allow all its free inhabitants habitually to assemble within its walls to discharge the duties of citizens."

It must not be inferred that this system of city-states existed in Greece from the beginning. It is certain that there, as elsewhere, ruder types of political organization preceded that which was so characteristic of Greek civilisation at its best. Wandering tribes do not build towns. The hill-fort and the unwalled village came before Athens in order of time, and left some faint traces of themselves in historic times.

Closely connected with our ideas of the State is our conception of government. We have seen that the State, in the modern sense of the term, implies the existence of a governing body. Even in barbarous communities we find some kind of rule established, and deference and obedience paid to some authority raised above the mass of the people. Immemorial nobility is to be met with in all branches of the human race; but how the distinction of rank arose in the first instance seems to be a matter of mere conjecture. It is possible, of course, to have distinctions of rank without such distinctions conferring any right of government. But, in practice, those who enjoy special honours usually secure posts of authority. As States advance in civilisation the organization of government becomes greatly developed, owing to the social needs of each community. But from whom is the authority to govern ultimately derived? Can the claim to rule or occupy official positions be based in the last resort upon inheritance, rank, caste, or divine right? Some answers given to these questions have in the past disturbed the peace of nations, and given rise to numerous changes in the constitutions of States. They have, however, now been answered virtually in one way, for the general conviction seems to be that no government ever existed which did not derive its power really from the consent of the governed. "Government," says Huxley, "is the corporate reason of the community." Where the sovereign is a compound body, as is the case now in every civilised government, the practical sovereignty rests with the people. In the British Constitution the three Estates of the Realm must agree before any measure can become law. A complicated but effective system of checks has been devised regulating the exercise of power by the monarch. But with whom does supremacy rest? Bagehot has shown that the British Constitution has given the sovereignty to the majority of the House of Commons. This seems to agree with the political genius of the Teutonic race in all times. Speaking of the Teutonic Assemblies, Professor Freeman says, "So in our land our ancient Witenagemots not only made laws, not only chose and deposed kings, ealdormen, and bishops, but sat in judgment on State offenders, and pronounced sentences of outlawry and confiscation. . . We must

remember that, carefully as we now distinguish the functions of legislator, judge, juror, and witness, it was only by slow degrees that they were distinguished. All grew out of the various attributes of an Assembly which, as being itself the people, exercised every branch of that power which the people has, at sundry times and in divers manners, intrusted to the various bodies which directly or indirectly draw their authority from that one sovereign source. In all times and in all places power can have no lawful origin but the grant of the people. The difference between a well- and an ill-ordered commonwealth lies in this: Have the people wisdom and self-control enough to see that in reverencing and obeying the powers of the State in their lawful exercise they are in truth doing homage to themselves, and giving the fullest proof of their fitness to discharge the highest right of men and citizens?"

The State is a natural institution. It takes form according to the special wants and circumstances, the innate qualities and spiritual aims of this or that people. We cannot forbear asking, What higher purpose, if any, does the State serve? Can the State be a factor in individual and social development? The State is concerned with human conduct, and its action is distinctly moral in character, and enforces morality. Although it is quite true that we "cannot make men good in the best sense of the word by Act of Parliament," yet for all that the State does exercise a great influence in maintaining and improving morality. It lays down a minimum of duty in many matters, and punishes when there is any wilful neglect of its regulations. For example, the State asserts that it is the duty of parents not only to support but to educate their children, and requires parents to act accordingly. But all this only confirms the account given long ago of the function of the State by the greatest of statesmen. Pericles, in his famous funeral oration, describes what Athens aims at doing for her sons, and what claims she has upon their devotion. It is a city-state of which he speaks: "We have a form of government which, from its not being administered for the benefit of the few but of the many, is called a democracy. . . We cultivate taste without extravagance, and study philosophy without effeminacy; wealth is with us a thing not for display but for reasonable use; the acknowledgment of poverty we do not consider disgraceful, but only the want of effort to escape from it." (Thuc., ii., 37–40.) All through the speech, says Pollock, runs the idea of the city-state being much more than a source of protection. It exists for the culture of men; it is the sphere of the citizen's higher activity. The glory of Athens is that she aims at producing, by means of a free

and generous education, the highest type of man. Aristotle also says, "The State was founded to protect life: it continues to improve it." In the words of Herbert Spencer, "complete life in the associated state" is the end of the social organism which we call "the State."

The account given not long ago of what the Glasgow City Council had done and intended to do for the benefit of the citizens of that important town shows that the spirit of the old Greek democracy still lives in the Aryan race. Indeed, what we see done in our midst for the improvement of civic life — the recreation-grounds, parks, library, art gallery, museum, and the like set apart for public use—the splendid benefactions of public-spirited citizens—are all an acknowledgment that the city is more than a mere dwelling-place, that we are all under an obligation to do what we can for the culture of men.

There are signs, however, not a few that men intend to use increasingly the larger powers of the State for the same end. It is considered by multitudes part of the proper business of the State to abolish abuses and grievances, and to promote the greatest happiness of the greatest number by direct legislation. That was the doctrine of Bentham, and it has taken hold of the minds of millions. It has become an article of belief that "the State has no excuse for being backward in well-doing."

We come now to that form of government which, after ages of struggle, has established itself in all the leading States of the world. Democracy is in possession of the field. The fact has been heralded in some such fashion as this: "The rule of the many seems now to be regarded as the final and inevitable form of government for all the civilised communities of men: that is held for a fact which may either be eagerly embraced or sullenly accepted. The few misgoverned because it was their interest to do so; the many will govern well because it will be their obvious gain." Whether these high hopes and confident predictions will be fulfilled the future will show. It will most probably be in the future as in the past, that the course of human progress will not be without lets and hindrances, disappointments and failures. It is easy and pleasant to cherish rosy imaginations, but an "unreined" democracy will unquestionably have its own peculiar difficulties.

The word "democracy" comes to us from the Greeks, and was used by Greek political writers with great exactness. But in the modern usage of the word a vulgarism has crept in which is wholly inexcusable. It is used sometimes to express a class of society with some connotation of opprobrium. In strict propriety it denotes a form of government in which all the

citizens who enjoy civil rights also enjoy political rights. Two great Greek thinkers, Plato and Aristotle, have left us lists of forms of government, classified as "normal" and "corrupt," and in each case democracy takes rank as a corrupt form. In Aristotle's view, democracy is the rule of the poor for their own advantage—an anticipation, by the way, of a rather widely-held modern opinion. Later writers, however, have given it a more favourable position.

Reference has already been made to Greek democracy as exemplified at Athens. It must be carefully remembered that the Greek political communities were small, and possessed a large slave population. The inhabitants of a single town constituted a State. Foreigners and slaves were not counted as citizens, and therefore could take no part in legislation or in the administration of justice. In Greece, then, democracy was exhibited on a limited scale, and under conditions totally unlike those of a modern democratic State. Modern statecraft has set itself a problem of formidable complexity. Whether it succeeds or fails the aim is undoubtedly high.

What does history teach as to the merits of a purely democratic government? It is sometimes charged against democracy that it is necessarily fatal to individual development, to robustness and originality of thought, to spontaneity of action. Its tendency, we are told, is to level down. Such was not the case at Athens. Professor Freeman says on this point, "Pure democracy—the government of a whole people and not of a part only—is a form of government which works up the faculties of man to a higher pitch than any other; it is the form of government which gives the freest scope to the inborn genius of the whole community and of every member of it. . . The democracy of Athens raised a greater number of human beings to a higher level than any government before or since; it gave freer play than any government before or since to the personal gifts of the foremost of mankind." This is high praise. There is but one drawback to it: it is that democracy at Athens appears to have been too forcing, and therefore lacked the quality of durability. But, however this may be, there is little room for doubting that a strong admixture of the democratic spirit in a government is necessary if a people is to achieve the highest results.

If we turn from Greece to Italy, there too we find the independent city the leading political idea, but Rome, by means of concessions to allies and subjects, was nearer becoming a nation in the modern sense than Greece. The history of the long struggle at Rome between the aristocracy and democracy is highly instructive from every point of view, chiefly from the close parallel it presents to what has taken

place in England since the Revolution. One thing is proved by it—namely, that the just demands of the people cannot in the long-run be resisted. A special good which resulted from the victory of the plebeians was that out of the patrician and plebeian elements of the body social was formed an assembly —the Roman Senate—which has been described as "the first political corporation of the world."

In our day the more advanced stages of democracy are represented mainly by the Republics of France, Switzerland, and the United States, and by the Australasian Colonies. Each of these types is well worthy of the closest study, but probably the one that will teach the most important lessons and have the greatest interest for mankind will be that of the United States. Here we have the sturdy, self-reliant Anglo-Saxon, long trained in the difficult art of self-government, applying on a vast scale the principles of democracy. This great social experiment, if such it must be regarded, is entitled to the most kindly and hopeful sympathy of all lovers of their species. We are hardly justified in predicting the failure of democracy in the modern world, and as exhibited in the Teutonic race, because of the breakdown of the two ancient republics. Teutonic democracy has been developed on different lines. Unlike the Greeks and Romans, the Teutonic did not pass through the urban commonwealth to the stage of national existence. "The nations of the Teutonic race," says Freeman, "alike in Germany, in Britain, and in Scandinavia, grew from tribes into nations without ever going through the Greek stage of a system of isolated cities." Where the process of development has been so diverse, the resulting type of democracy, if less brilliant, may prove more permanent. It is certainly less concentrated and stimulating than that of Greece, and on this ground alone might be expected to be more lasting. A widely-scattered population, with most diverse interests, must exercise much coolness and consideration in order to carry on government with any degree of success. It is in just such circumstances and under such conditions that modern democracy lives and acts.

The innate tendency of the Aryan race to self-government has already been touched upon, but in the Teutonic branch the system of representation has enabled the people at large, when unable to be present in person at the law-making body, to have a voice in the government of themselves. Ancient democracies had no representative system. This happy device is distinctive of Teutonic democracy, more especially in recent times; but science has aided and abetted the genius of the race, and rendered the modern development of democracy possible and inevitable. By the telegraph and other means of rapid communication contagious thought is enabled to travel

from the centre to the most distant extremities of the body politic. Political changes in England may be known in New Zealand in a few hours. The Press, too, exerts its mighty force in fostering and stimulating the democratic spirit. Through it the people can make their thoughts and wishes known, and so influence and guide their representatives. In this way the community at large becomes a kind of parliament. Political topics and measures are discussed and criticized from a hundred points of view. The spread of education and consequent enlightenment of the people, tending as it does to equalise social conditions, is also a contributory force in the same direction. Acted on by all these agencies, the civilised world itself seems to be in process of unification.

In some such way as this modern democracy is to be accounted for, and under conditions of this kind it is operative. But there is one other cause, very powerful and persistent in its action, which has also, in my opinion, helped to produce the social development going on in our civilisation—I mean the Christian ethic. There can be no question at all as to the existence and potency of this force. Has it also played an important part in the evolution of our democracy? Contradictory answers will probably be given to this question. But, without making the Christian ethic responsible for all the doings of democracy, or for what may be called the accidents of the movement, the uplifting of the people may be said to be essentially its work. The opinion of the author of "Social Evolution" is, I think, sound in the main: "All anticipations and forebodings as to the future of the incoming democracy founded upon the comparisons with the past are unreliable or worthless. For the world has never before witnessed a democracy of the kind that is now slowly assuming supreme power amongst the western peoples. To compare it with democracies which held power under the ancient empires is to altogether misunderstand both the nature of our civilisation and the character of the forces that have produced it. Neither in form nor in spirit have we anything in common with the democracies of the past. . . The gradual emancipation of the people and their rise to supreme power has been in our case the product of a slow ethical development, in which character has been profoundly influenced, and in which conceptions of equality and of responsibility to each other have obtained a hold on the general mind hitherto unparalleled. The fact of our time which overshadows all others is the arrival of democracy. But the perception of the fact is of relatively little importance if we do not also realise that it is a new democracy."

The advance of democracy, whether we approve or deplore it, is an undeniable fact. The unmistakable signs or proofs

of the sovereignty of the people are—(1) The extension of the parliamentary franchise so as to include all citizens except children, criminals, and the insane; (2) the eligibility of citizens of all ranks for nearly all offices of State; (3) the supremacy of legislation.

What are some of the principles of the new democracy? Amongst these we must enumerate "equality of rights"—a somewhat vague phrase, but which I take to mean that all men are equal before the law or in respect to prohibition and restriction, and that every man has a right to be heard in all matters that affect him. Another principle is that majorities must rule—or, in other words, that the majority for the time being represents the will of the people. A third principle is an increased and increasing use of the machinery of the State in the interests of the masses of mankind. This is done chiefly in the way of compulsory, permissive, or other kinds of legislation. As regards the intervention or limits of the State the greatest diversity of opinion prevails. There are those who would limit the function of the State to the protection of life and property, and there are those who would fly to Government on any and every occasion. Between these two extremes there are many varieties of opinion. The truth seems to be that no hard-and-fast rules can be laid down on the subject. "As to the question in its general bearing," says Sir Frederick Pollock, "I do not think it can be fully dealt with except by going back to the older question, What does the State exist for? And, although I cannot justify myself here at length, I will bear witness that for my own part I think this is a point at which we may well say, 'Back to Aristotle.' The minimisers tell us that the State exists only for protection. Aristotle tells us that it was founded on the need for protection, but exists for more than protection—*γινομένη μὲν οὖν τοῦ ζῆν ἕνεκεν, οὖσα δὲ τοῦ εὖ ζῆν.* Not only material security, but the perfection of human and social life, is what we aim at in that organized co-operation of many men's lives and works which is called the State. I fail to see good warrant of either reason or experience for limiting the corporate activity of a nation by hard-and-fast rules." It seems to me that the doctrine of pure individualism is as much opposed to what may be called municipal socialism as to State interference. Be this, however, as it may, in this country the State has established an insurance department, and has undertaken the construction and management of railways—and yet the world goes round.

As regards the programmes of democratic legislation, we find economical and social questions mixed up with those which are purely political. Land-nationalisation, co-operation, profit-sharing, limitation of the hours of labour, loans of

public money to settlers, and the like, frequently appear as matters for special legislation. The fact that large numbers of people have come to think that questions of this kind should be dealt with in the way proposed shows how the beliefs of men as to the powers and duties of the State have been revolutionised.

The new democracy is not quite satisfied with the Constitution as it stands, but it shrinks, very wisely I think, from making any sweeping and sudden changes. The existence of a second Chamber not directly responsible to the people is sometimes felt to be a grievance, more especially when the offending Chamber is in opposition to the popular will. Loud cries are heard from time to time for its reform or abolition, but in cooler moments extreme measures find no supporters.

In all democratic communities the greatest interest is taken in education. It is curious to note that in this respect the modern democratic State is but following in the steps of Aristotle. About one-eighth of his treatise on politics is occupied with the theory of education. One of the marvels of the age is the sacrifice made by the State to provide education for its citizens. Young and small communities, equally with the old and strong, are impressed with the importance of education. In England, France, America, Australia, and New Zealand, primary and higher education takes almost the first place in the consideration of the State. It is a true and healthy instinct that prompts this care for education; and no greater service can be rendered to the community than that of helping to improve and develope the system and methods of education. The theory or ideal of education as held by the State is still very imperfect, and the results of such education as is given are not all that could be desired. Our great men differ on the subject, so it is no wonder if lesser folk are perplexed and make mistakes. Froude relates somewhere that Lord Brougham once said he hoped a time would come when every man in England would read Bacon, but that William Cobbett said he would be contented if a time came when every man would eat bacon. The proper combination of the literary and practical elements in education is still a matter of uncertainty and "hopeful blundering."

What does the democratic form of government require from the citizens? The political machine is not self-acting. If it is worked by selfish, unprincipled people the results are sure to be disastrous. The well-balanced intelligence, superior to passion and prejudice, such as is required for the best government is very rare. We may safely say that unless the people as a whole are intelligent, thrifty, enterprising, industrious, and above all moral, their efforts at self-government will utterly fail. Mr. Bryce has well said in his reflec-

tions on American democracy, "It is an old saying that monarchies live by honour and republics by virtue. The more democratic republics become, the more the masses grow conscious of their own power, the more do they need to live not only by patriotism, but by reverence and self-control, and the more essential to their well-being are those sources whence reverence and self-control flow."

It would be fatal to ignore the fact that democracies are liable to special difficulties and dangers. The objection sometimes urged against popular government, that the people at large lack the requisite training and ability, may be met by saying that "it is not necessary they should be competent, the essential thing is that they should be interested." True as this may be, there are, notwithstanding, grave abuses to which democracy as such is peculiarly subject. Experience proves this beyond dispute. To take but one point, the administration of the law: It is of vital importance to a democratic community that when laws are made they should be strictly and impartially enforced. The stability of the community rests upon this. Any disposition and effort on the part of an orderly people to shield offenders from the due reward of their deeds are wholly mischievous, and tend towards anarchy. It cannot be too often repeated that the firm and just administration of the law is of the first moment to any State.

Does not a danger also lurk in the change that is coming over the "representative"? He is turning into the paid delegate, a sort of salaried official. We all know the reason given for the payment of members of Parliament. The reason is probably sound, but the danger remains. The candidate for parliamentary honours would now be laughed at who should venture to say, as Burke did to the electors of Bristol, "It ought to be the happiness and glory of a representative to live in the strictest union, the closest correspondence, with his constituents. Their wishes ought to have great weight with him; their opinions high respect; their business unremitted attention. It is his duty to sacrifice his repose, his pleasure, his satisfaction to theirs; and, above all, ever and in all cases to prefer their interest to his own. But his unbiassed opinion, his mature judgment, his enlightened conscience he ought not to sacrifice to you, to any man, or to any set of men living. . . Authoritative instructions, mandates issued which the member is bound blindly and implicitly to obey, to vote, and to argue for, though contrary to the clearest convictions of his judgment and conscience, these are things utterly unknown to the laws of this land, and which arise from a fundamental mistake of the whole order and tenour of our Constitution." Any candidate ven-

turing to assert himself thus nowadays, and to speak in this strain to the electors, would probably hear the word "Fudge!"

But, if democracy has its peculiar risks, it has some safeguards in modern life. Whether these will prove completely effective remains to be seen. The first of these is freedom of discussion—the fullest freedom, within reasonable limits, to express opinions. "Experience and discussion may be trusted to make error find its level." Another safeguard is the decentralisation of power by means of local government. There are many things which local bodies, acting under the delegated authority of the State, can do better than the central Government. Mismanagement on the part of such bodies is more easily discovered and rectified than when the central Government is at fault. Considerations of party and struggle for political power and place do not embarrass the actions of local bodies as they do those of the central Government.

Suppose the success of democracy assured, what benefits may we hope to derive therefrom? Is democracy itself the final form of government, or is there a beyond? The late Dr. Pearson, in his book on "National Life and Character," maintains that democracy will find its consummation in State socialism, that the leading nations of the world are tending towards a condition of stationary civilisation, and that the increased importance of the State will prove disastrous to the energy and independence of thought of the individual. "It is now more than probable," he says, "that our science, our civilisation, our great and real advance in the practice of government, are only bringing us nearer to the day when the lower races will predominate in the world; when the higher races will lose their noblest elements; when we shall ask nothing from the day but to live, nor from the future but that we may not deteriorate." This is a sufficiently dismal vision of the future. After the fierce struggles and stern discipline of the ages, what more pitiful issue than hopeless, irresistible decay of character? In this connection it is a little pathetic to remember that here in New Zealand there is no one left to whom we may give a vote, and that we are thought to have gone a long way in the direction of State socialism.

It is proverbially hard to confute a prophecy, and most people prefer to speak after the event. But Dr. Pearson's anticipation is not shared by all who venture to forecast the future of man upon earth. A greater teacher than he cherished a very different belief. Tennyson, while he wisely bids us not "deal in watchwords overmuch," never loses hope in the progress of mankind towards a better and happier condition upon earth:—

We are far from the noon of man: there
Is time for the race to grow.

This is a loftier and truer teaching. The instinct of progress has not been implanted in us merely to be baffled and disappointed. We know that the future, whatever it be, will emerge from the present as the present has emerged from the past. But the Muse of history, if we are to put any faith in her teachings, seems to bid us look with confidence to the future where lies the golden age. "History is the best tonic for drooping spirits."

Even if completely successful, democracy will not fulfil the expectations of those who are loudest in its praise. It cannot turn life into a playtime. Strenuous effort, labour—patient, steady, intelligent—will be as necessary as ever. All the virtues which have marked man's advance hitherto will still be indispensable. In all that makes life noble and really useful the prize will be to him only who strives. Competition may conceivably be lessened, but that should be only to set free our energies for employment in other directions.

Let us interest ourselves in politics if we will: it is, indeed, our duty to do so. But let patriotism govern our political ideals and actions. Above all, we should remember that national strength and greatness can never be attained, nor can they endure, if our lives are divorced from morality.

## ART. XIV.—*The Training of Teachers for Primary Schools.*

### By the Rev. J. BATES.

[*Read before the Auckland Institute, 5th August, 1895.*]

IN this colony, as in other democratic communities, the State has assumed the responsibility of providing schools for elementary education. It would seem as if the democratic movement was under some necessity to ally with itself popular education. At any rate, the two go together. In England, Germany, France, Switzerland, the United States, and in the colonies of Australasia it has been the special care of the several Legislatures to devise and establish systems of primary instruction. Large sums of money are freely voted and expended annually on education, and the demands on the public purse under this head keep ever growing. Some of the best intellects are busily employed in adapting the various systems of education to the requirements of the people, and, as fresh educational wants make themselves felt, strenuous efforts are made to satisfy them. In view of these facts,

democracy, in its many phases, may claim to be realising the dream and wish of the poet:—

> O for the coming of that glorious time
> When, prizing knowledge as her noblest wealth
> And best protection, this imperial realm,
> While she exacts allegiance, shall admit
> An obligation, on her part, to *teach*
> Them who are born to serve her and obey.

The foremost countries of the world at the present day are those in which the common school has most widely and deeply rooted itself. Backward and stationary civilisations, if they wish to fall into line and keep step with progressive societies, have to adopt some system of universal and compulsory education. "Education in Japan is plentiful, good, and cheap," says Sir E. Arnold. A Turkish statesman and patriot, on his death-bed, recently urged his royal master to establish schools throughout Turkey, and thus introduce one of the most potent factors of Western greatness.

Few will question that the State, in thus charging itself with the work of elementary education, is acting well within its rights. The instinct of self-preservation would alone impel the modern democratic State to educate. To avoid relapse into barbarism, to prevent the growth of "a savage horde among the civilised," the State must make due provision for the enlightenment and moral culture of its citizens.

And, as the State has the right, so it is under the obligation to provide universal education in the interests of healthy and intelligent citizenship. This function and duty cannot be relegated by it to any other organization, or to private enterprise, for the simple reason that the State alone possesses the coercive power required to make a system of popular education effective. While the co-operation of all organizations and individuals is desired and encouraged in the work of national culture, the general conviction is that the control of elementary education must be reserved exclusively for the State. The education thus provided is not a charity. All have a right to it, because all help to pay for it. Hence it is that education, like religion, is now everybody's concern.

Now, the training of teachers for their work is the most essential part of any proper scheme of education. The day has gone by when any one was thought good enough to teach an elementary school. Men who had failed in other occupations had always teaching to fall back upon. "When a man's the sport of heaven, to keep a school the wretch is driven." People in reduced circumstances thought it right to apologize for earning their living by teaching. All this has been changed. Teaching is now commonly regarded as a serious and honourable occupation or profession—an occupa-

tion demanding knowledge, skill, enthusiasm, and good moral character. The day is at hand, perhaps, when moral worth will be regarded as of even greater value than knowledge and technical attainments.

The careful training of the teacher should, I think, occupy the first place in the national programme of education. Without duly-qualified and self-devoted teachers, fine buildings and costly appliances will be of little worth. Apart from the service which the able and zealous teacher renders to the intellectual and moral life of the nation, his training is of importance as a kind of national investment. From every point of view it is necessary to have capable men in charge of our schools; and the more capable they are the better.

As regards the preparation of teachers for their work, two points are to be distinguished—namely (*a*) their general knowledge; and (*b*) their professional training. If their general knowledge is sound and ample they are more able to profit by their technical instruction, and have more time for practice.

Let us see what provision has been made for the training of teachers in one of the old countries of the world. Germany has led the way in the work of popular education, and there from the time of the Reformation the training of the elementary-school master has been steadily kept in view. There we find the training-school and the training-college for teachers in the highest state of efficiency. The whole course of training, usually extending over six years, is divided into two periods—two or three years being spent in the training-school, and the remainder in the training-college. The object of the training-school is thus set forth: "To provide that kind of general training which is calculated to afford a sure foundation for the technical training of the elementary-school teacher." In other words, the training-school provides such instruction and training as are supplementary to the elementary school and preparatory to the training-college. With respect to the latter institution, "the object of the instruction given there is to confirm the knowledge acquired in the preparatory course and to give it progressive development, to insure familiarity with the principles of the theory of education and instruction, and to give theoretical and practical directions as to the correct treatment of the separate subjects of an elementary school." The theoretical training comprises four principal subjects: (*a*) Pedagogy; (*b*) theory of instruction; (*c*) psychology; (*d*) special method. The practical training consists chiefly of lessons given in the practising-school under the supervision of a master of method. These lessons are afterwards criticized both by the master and by fellow-students.

But, good as the German training institutions are, they do not fully satisfy the aspirations of the teachers themselves. It should be noted in passing that all the more important educational reforms in Germany have originated with the teachers. Their suggestions have seldom been at first acceptable to the Government, but, in the end, reasonable changes have been made, and the substantial justice of their demands acknowledged.

The report of the United States Bureau of Education published last year contains a historical review of the German and other systems of training for teachers. In the sixth section of the review a summary is given of the opinions of leading educators on training institutions. The German Teachers' Union, a body sixty thousand strong, had submitted certain inquiries to forty-two of the ablest directors of normal schools. Seventeen of those addressed answered all the questions put to them. The rest declined to answer, chiefly to avoid what appeared to them criticism of the Government.

The first question was as follows: "Is it advisable to organize the normal schools in such a way that they can offer professional—that is, pedagogical—training exclusively, or should they also offer academic instruction and general education, which must be the basis of professional work?" Thirteen of the seventeen replies were in favour of the separation of general education from purely professional training. Among the reasons given were the following: "The purpose of a teachers' training-school is to prepare its students for their profession; the art it has to teach is the art of teaching; the school can accomplish this task satisfactorily only if the general education of its students has to a certain extent been completed before they are admitted; the mixture of general preparation and professional training now existing is the chief obstacle to progress in the training of teachers, because it necessitates a low degree of requirements for the general education—lower than is desirable in the interest of popular education."

The second question was, "In what manner, in case the first question be answered in the affirmative, shall the general preparatory education be obtained? Is it desirable to (*a*) establish special preparatory schools for teachers, or (*b*) should the existing normal schools be extended downwards by establishing preparatory courses, or (*c*) is attendance at secondary schools to be commended? If so, which one—the classical (gymnasium), or the modern (real gymnasium), or the citizens' high school (without Latin)?" Six replies were in favour of the existing high schools, and all recommended the citizens' high school as the most suitable.

These are the only questions that concern us in New

Zealand. The section concludes thus: "These opinions, rendered as they are by the foremost normal-school educators of Germany, Austria, and Switzerland, have made a profound sensation among teachers and Government authorities. The educational Press has reproduced them and commented upon them. Even the political Press in Germany has considered them the most authoritative and important contribution to the question of teachers' training of late years, and expressed the hope that the provincial as well as the central Government will base future reforms on the advice of these gentlemen.

"The further fact that this symposium was called for and published by the National Union of Teachers—a union that has nearly sixty thousand members—is most significant, and proves that the teachers themselves are not satisfied with the professional education the State offers them."

It will seem like an instance of anticlimax when we turn from these high themes to the arrangements made for the training of teachers in New Zealand. We have adopted, probably from motives of convenience and economy, the pupil-teacher system from the Mother-country. This system, which is really formed on the model of apprenticeship in trade, was long ago tried in Germany and abandoned. Even in England it seems to be showing signs of weakness, and is undergoing modification. Her Majesty's Senior Chief Inspector of Schools in the Metropolitan Division, in his report last year, thus wrote: "The training of teachers in the science of teaching still lags far behind the training of teachers in Germany or France. In England we are still dependent for our supply of teachers in elementary schools almost exclusively upon the pupil-teacher system, and it seems that the sources of supply as regards men-teachers are failing . . . People interested in elementary education look upon this difficulty as one which will at no distant day have to be faced, and the recruiting of elementary teachers from scholars who have enjoyed the advantages of a good secondary education, as in foreign countries, is a matter well worthy of consideration." So much as regards failure. That the system is being modified will be obvious from the following extract from an article on our voluntary schools which appeared in the *Contemporary* of February, 1895. The writer (Archdeacon Wilson), himself a highly distinguished schoolmaster, says, "A School Board can not only provide special instruction for its pupil-teachers, but can afford to duplicate its staff of such teachers, and thus give them full leisure for private study." And in a note the Archdeacon says, "If the Education Department would recognise two pupil-teachers, each working half-time in school and half-time in central classes, as equivalent to one pupil, the

difficulty of properly educating pupil-teachers in voluntary schools would be diminished."

What, then, is done by the Education Department of New Zealand, and the educational authorities of Auckland in particular, for the training of teachers? The department holds two examinations annually for Classes E and D, and grants certificates of competency to successful candidates; it recognises the University degree by creating for it the three higher grades—C, B, A; it also recognises the matriculation examination and the Junior and Senior Civil Service examinations, and makes certain concessions in favour of those who have passed these tests; it has framed certain regulations concerning the employment and training of pupil-teachers; lastly, it has made regulations respecting normal schools. Subject to the general provisions of the Education Act and to the regulations of the department, the Education Boards have done what they could to keep up the supply of qualified teachers.

A number of young people are taken on year by year; after a brief period of probation and on the favourable report of a head teacher they are indentured as pupil-teachers, appointed to some school, and generally put in charge of standards. They are required to work five hours daily in school, and are entitled to receive, out of school-hours, five hours' instruction per week from head teachers or their deputies. They are examined annually, and are expected to present themselves as soon as possible for examination in Class E or D. This, I think, is all that is done to aid them by the educational powers that be.

The fact that their qualifications, as shown by examination and Inspectors' marks, are rising, only proves capacity and desire for improvement on the part of the teachers themselves. To get through the different grades they must have recourse to outside help.

The objections to a scheme of this kind are obvious and weighty. Young people, from fifteen to seventeen years of age, whose training is avowedly *nil* or very incomplete, whose stock of knowledge is very meagre, are put to teach—the very work for which they are least fitted. As our schools are staffed and organized it is impossible for head teachers to exercise any adequate and effective supervision over the teaching of their junior subordinates. The system, if such it can be called, is unfair alike to the young teacher and to the scholar. It is indefensible except on the ground of want of means. It has been tried elsewhere under favourable circumstances and deliberately rejected. This being so, it would be surely well for us to take advantage of the experience of others and avoid repeating educational blunders.

With respect to the general education of the teacher, the

best agencies are, in my opinion, the secondary school and the university. It will be greatly to the advantage of teachers to share in general culture with the members of other professions. In advocating the fullest possible use of the university and the secondary school in the preparation of our teachers I am but complying with the spirit of the Education Act and of the regulations of the Education Department. In other countries, too, as we have seen, the secondary schools are likely to be more closely linked to the primary schools in the great work of helping to train the teachers of the latter.

In addition to adequate general knowledge, the student who aspires to be a teacher must also have practical training under the direction of some highly-qualified man. To effect this there must be established, as suggested in the regulations of the department, a practising-school, through which all our young teachers should be required to pass.

Under present conditions we cannot hope for the best results, and our educational system, notwithstanding its many excellencies, is maimed and halting. Some reform is needed; but reform to be real and lasting must be preceded by thorough knowledge of the weaknesses and deficiencies of existing arrangements, of what is needed, and of what is aimed at in other countries which are far ahead of us in educational evolution.

## ART. XV.—*Abel Tasman and his Journal.*

By DR. T. M. HOCKEN, F.L.S.

[*Read before the Otago Institute, 10th September, 1895.*]

Plate I.

IN fulfilment of a promise made during the last session of this Institute, I have now the pleasure of laying before you a translation, made by myself and my wife, from the original Dutch of that portion of Tasman's Journal relating to the discovery of New Zealand. It is the first time that this has been fully translated.* I shall also give

* Translated from "Journaal van de Reis naar het onbekende Zuidland, in den Jare 1642, door Abel Jansz. Tasman, met de Schepen Heemskerck en de Zeehaen. Medegedeeld en met eenige Aanteekeningen voorzien, door Jacob Swart," &c., &c. "Met eene Kaart. Te Amsterdam, bij de Wed. G. Hulst van Keulen, 1860." Tasman's Journal was lost for over two hundred years. When it was found Swart published it in its entirety, as above, in 1860. A copy of this I possess, and from it my translation has been made.

an account of the Journal generally, of the circumstances under which it was written, and of Tasman himself. During the latter part of the sixteenth and the earlier part of the seventeenth century the Dutch were pre-eminently the rulers of the sea. They had superseded the Spanish and the Portuguese, who so long had been in the van of maritime discovery and adventure. Their ships were better built, found, and commanded than had ever been the case before. Their navigation, laws, and rules were for the time of quite an advanced kind; and, with that quiet perseverance and sturdy courage which, under the name of Dutch phlegm, have always been characteristic of the nation, their merchants had secured and held the trade of the world. England's day was then but in high dawn; and, though now she is, and for long has been, the mistress of the seas, at that time she held but a second if not a third place. Early in the seventeenth century Holland penetrated into the Indian Archipelago, and amidst its numberless fertile islands developed amazingly the wealth of her trade. In 1610 she founded the capital of Batavia on the Island of Java, and, though surrounded by hostile native princes or chiefs, she maintained her position and security in this centre. The affairs of this Dutch East India Company were managed by a Governor-General and Council, who, by persistent courage and enterprise, maintained in those parts of the world that renown which their countrymen had won elsewhere. At no period in its history was the company so prosperous and flourishing as between the years 1630 and 1680. That half-century closed, it became involved in the quarrels and politics of the native Javanese States, and then commenced its commercial ruin. In 1636 Antony van Diemen was appointed Governor-General, retaining office for nearly ten years; and no Governor equalled him in energy and sagacity. It was during his rule that Tasman's voyage, of which we are now to speak, was undertaken.

Tasman was born in 1602 or 1603, at Hoorn, in the north of Holland, a town on the borders of the Zuyder Zee, where so many bold sailors were bred, and where, it has been stated, descendants of his family still remain. But, indeed, we know little of Tasman's personal history beyond that contained in his Journal. In this he has truly bequeathed us his monument, though underneath it lies little more than a shadow. An old engraving of him is to be seen in the Christchurch Museum; and it would seem that some personal description is given by M. Dozy in "Bijdragen de Taal Land en Volkenkunde van Nederlandsch-Indie" ("Contributions to the Language, Country, and People of Dutch India"), 5th series, vol. ii., p. 308; but of this I know nothing. He died at Batavia in 1659. By direction of Van Diemen he was despatched in 1639,

and soon after his arrival in the settlement, under the command of Captain Matthys Kwast, who was instructed to proceed through the Western Pacific to the Philippines, and there to make search for the fabled Gold and Silver Islands. These are now known as the Bonin Islands, east of Japan. This was most probably Tasman's first voyage under the auspices of the company; at its close he sailed in the Indian seas until 1642, and then commenced his great voyage of discovery.

Here it will be interesting to contrast the mode of present-day sailing with that whereby those who went down to the sea in ships in Tasman's time made their truly perilous voyages. Now navigation has been reduced to a fine art, as well as to a precise science—so fine and so precise that it may be generally affirmed that disaster at sea is the result of carelessness, often of gross carelessness. Those floating palaces which now cross the waste of waters in every direction are timed to reach their destination with the punctuality and almost the speed of a railway-train. A few days, or weeks at most, of safe and pleasant travel now represent the weary months of discomfort, dangers real and imaginary, and the scourges of scurvy and dysentery which were too often the lot of those who led the way. All this was first rendered possible by the invention of those instruments, the sextant and chronometer, which now daily tell the sailor his exact position on the trackless ocean. Add to these his accurate chart and nautical tables, and what evil can befall him, unless through great neglect or rare misfortune? When undertaking early voyages of discovery it was usual that two, three, or more vessels should form the fleet. This was a precaution in all ways wise, contributing as it did to mutual courage, safety, and companionship. The commanders and officers formed a committee, or council as they termed it, and whenever any difficulty or dilemma arose the members of this council were summoned by signal aboard the principal vessel of the expedition, and there decided what course was best to follow. These occasions seem to have been frequent, as we can well fancy. The vessels, with their high poop, high forecastle, and round bows must have looked picturesque enough. They were greatly foreshortened, too, for it was considered that a vessel whose length much exceeded its breadth was absolutely unsafe and not unlikely to capsize. Four or five knots an hour was good average sailing; much more frequently the distance traversed in a day did not exceed fifty or sixty miles. The tonnage of those early vessels varied much: some measured 300 or even 400 tons; but the perils of many a long voyage were encountered in little vessels of no more than 40, 60, or 120 tons burthen. The dietary scale in Tasman's

time was something as follows: To each man—one good cheese for the whole voyage; three pounds of biscuit, a quartern of vinegar, and half a pound of butter per week; on Sunday, three-quarters of a pound of meat; on Monday and Wednesday, 6oz. of salted cod; on Tuesday and Saturday, a quarter of a pound of stock-fish; on Thursday and Friday, three-quarters of a pound of bacon with grey peas; and at all times as much oatmeal as could be eaten. Those were not the days of coffee, tea, or teetotalism, but of strong rum and arrack, which were regularly distributed; and whoever was so lucky as first to descry land from the masthead had his ration doubled. The instruments and methods used for determining the position at sea—the latitude and longitude—were of the most primitive and, one might say, ineffective kind. Cartography was in its infancy, and the few charts that were placed in the sailor's hands were projected on principles so regardless of the proportions of the sphere as to be absolutely misleading and dangerous. The simple device of the log for measuring the rate of sailing through the water was introduced but twenty years prior to Tasman's time. Before that it was usual to estimate the amount by guess. The sun's altitude, and the relative position of the heavenly bodies, which are now calculated with such accuracy by means of the sextant, and which, with the chronometer, give the true position, were then ascertained by very crude instruments—the astrolabe, and, later, the cross-staff; specimens of which I exhibit. The astrolabe was made of a circular piece of metal, 7in. in diameter, divided into quadrants, one of which was divided into degrees, and suspended freely, as one might suspend a watch by its ring. A broad pointer or index, 1¼in. wide, traversed the face of the instrument, and was divided through the exact middle of its length by a line termed "the line of confidence." Close to each extremity of the index, and perpendicular to it, a small plate was fixed, with two small holes, one larger than the other, but both being exactly over the line of confidence. These were sights, and when the object viewed was seen in exact line through them—the sun or moon, or a star—the angle was read off. The cross-staff, which was probably used by Tasman, was a squared rod of wood, 3ft. in length, upon which were denoted angles or degrees, and having a sight at the eye-end. Upon this, by means of a slot, slid at right angles a second rod of wood, about 2ft. in length, having a sight at each terminal, and through these sights the object was viewed, the object-rod, if we may so call it, being adjusted upon the other, which was pointed plane to the horizon, and the angle read off. In this rough way was the sun's altitude taken, and probably a rough attempt was often made to take what

sailors call a lunar distance. An improvement was made on this cross-staff by adding one or two shorter transoms for reading smaller angles. On some of those odd frontispieces which embellish ancient atlases or geographies may be seen a sweet little cherub holding aloft an emblem of the cross apparently, but really this cross-staff. A hundred years after the introduction of the cross-staff came Dr. Hadley's quadrant (about 1731), which has developed into the perfect sextant of to-day. But with his tables of declinations, which were even then calculated, and this simple instrument, Tasman and his brethren succeeded in taking their latitudes with remarkable accuracy, as is evident by inspecting the coast-line of his Staten Land, which I have placed side by side with that of our New Zealand. But how he succeeded with his longitudes is quite a different matter. As we well know, longitudes can only be calculated perfectly by knowing the difference of time at two meridians, and this must be gained by the aid of accurate timekeepers. In Tasman's day, the very few clocks and watches in existence were but of little use in keeping the time. The problem of longitudes at sea was always considered of the utmost importance amongst maritime nations. Even at the beginning of this century it was thought that it would never be solved, owing to the difficulty or impossibility of ever constructing watches that would keep perfect time. As indicating this sentiment, the so-called Board of Longitude advertised, at the beginning of last century, in Queen Anne's reign, that they would give rewards of £10,000, £20,000, and £30,000 respectively to him who should discover a means of taking longitudes at sea to within sixty, forty, and thirty geographical miles. Precision within these limits was not thought of or expected. This liberal offer stimulated invention, and Dr. John Harrison, an ingenious mechanician, who for years devoted himself to making improvements in clocks and watches, succeeded in 1764 in gaining the prize of £20,000 with a watch—or chronometer, as we should now call it—which was twice carried on a voyage to the West Indies. The time kept was admirable, and insured an accuracy of longitude to within ten or twelve miles. One of Harrison's watches, which, by-the-by, cost from £80 to £100 apiece, was carried by Captain Cook on his first great voyage of discovery. Messrs. Wales and Bayly, who accompanied Cook's second expedition, state, in their astronomical observations of the voyage, published in 1777, that the longitude could then be computed to within the fifth or sixth of a degree—that is, to ten or twelve geographical miles. The earliest account I can discover of the use of timekeepers at sea is in 1668, when two watches were used together on the same vessel. The result was not satisfactory, as may be

learned from the manuscript in the Sloane collection of the British Museum. It is but within the last few years, comparatively speaking, that chronometers have been in universal use.

The last antiquated marine instrument to which I shall refer as used in Tasman's time is the sand-glass. These were constructed of different sizes, so as to measure periods of four hours, one hour, and half an hour The survival of them at sea is to be seen in the 28-second log-glass, used when the log is taken; and on the kitchen mantelpiece, for boiling eggs. Hour-glasses were used in the last century in churches, placed on the pulpit-ledge in view of the congregation, where they regulated the length of the sermon. Much improvement has been effected in this direction during the last few years, the regulation length of sermons now being about twenty minutes. The time at sea was roughly kept by the half-hour glass, which was always in sight of the steersman. When the last grains of sand had run out he reversed the glass, striking a bell at the same time as a mark of the time. This was repeated until the glass had been turned eight times, and the bell struck eight times. Thus four hours had elapsed, the watch was completed, and the new watch took charge of the ship. And so Tasman, in denoting time, speaks of so many glasses in such-and-such a watch: thus, three glasses in the morning watch would be three half-hours past 4 a.m.—that is, 5.30. These sand-glasses were made with the greatest care and accuracy. The upper and lower sections were separated by a thin metallic plate, perforated with a fine pin-hole, through which the sand ran. The sand was carefully selected and dried—iron-sand, I think, being preferred, as being a rounder, more regular grain, and therefore affording the least friction. When the running of this sand through the pin-hole had been adjusted and timed the whole was hermetically closed by lashing, and was further protected by a wooden framework. Now, it is quite possible, and not unlikely, that, conjointly with dead-reckoning, Tasman took his longitude by the help of a four-hour glass of this description, set agoing at noon when about to leave port. Of course, there would be some error, due to the expansion or contraction of the glass, or to failure in turning at the exact moment when the last grains of sand had disappeared. Still, with all faults, this was the only method of securing any reasonable approach to a fixed meridional time. If Tasman did not adopt it, then his only other way of estimating his daily longitude was by means of dead-reckoning—that is, by reckoning the number of miles sailed over an east or west course in twenty-four hours. This rough method has been used by sailors for centuries, and is used at the present

time whenever a clouded sky interferes with a due observation of the sun. It is untrustworthy at the best, from causes which are very evident. A vessel may make much lee or lost way from some ocean current, which insensibly drifts her out of her course; and there are other sources of error. Hence we shall not be surprised to find that, whilst Tasman's latitudes are very correct, his longitudes are often considerably at fault, even so much as three or four degrees. As will be observed in this map of New Zealand, upon which I have projected his daily course, he is wrong on the average about 3° W.—that is, about 170 miles from the coast. This vast discrepancy will exhibit very clearly the imperfection of nautical methods two hundred and fifty years ago, and that Queen Anne's Board of Longitude might well be content with any means whereby the position at sea might be known within thirty or forty miles of the true one.

Before the discovery of America — the so-called New World — the westernmost point of the then known world was the Island of Ferro, one of the Canaries, and it was therefore selected by old geographers as the prime meridian from which all other meridians were calculated. Afterwards, and somewhat before Tasman's time, the Peak of Teneriffe, also in the Canaries, was selected, probably because of its conspicuous height. It is from this meridian, then, that Tasman gives his longitudes. In the present day all nations agree as a matter of great convenience to calculate from Greenwich, with the exception of the French, who, whilst notating their parallels from Paris, nevertheless add the Greenwich equivalent. Whilst Tasman gives, in both his chart and Journal, his positions as deduced from the Peak of Teneriffe, they must really be computed from the Island of Mauritius, which, as we shall presently see, was his final point of departure after leaving Batavia. So that, to reduce his longitudes to those of Greenwich, we must subtract, say, 21° 2′ from them—made up of, say, 16½° for Teneriffe and 4½° error for Mauritius. We then have remaining what may be called "personal errors," caused by inability to calculate his position exactly, and which, as has been seen, often amount to three or four degrees. Another explanation should here be made. The distances sailed are in Dutch miles, fifteen of which are equal to one degree. A Dutch mile is equal to about four English, so that if Tasman gives as his day's work twenty miles we should reckon that he had sailed eighty. In making this translation I have preferred to give Tasman's own unaltered details; those who desire to make the corrections can do so from the data I have given.

In a paper read before this Institute last year I gave some account of Tasman's Journal, and showed that it had never

been edited and published in its entirety until so recently as the year 1860, when Heer Jacob Swart, of Amsterdam, gave it to the world in the original old Dutch, which not only differs greatly from modern Dutch but is apparently a dialect. From this edition this translation has been made, and I think it may be truly said that it is the first full translation hitherto made. It was with great pleasure I learnt a few weeks ago that the firm of Heinrich Müller, of Amsterdam, is now preparing to publish a limited number of copies of the full text in English. This will be as valuable as interesting. Then, as good things sometimes come together, I saw recently a few sheets of what apparently is to be the future New Zealand Reader for use in our primary schools. These sheets contained some parts of Tasman's Journal, evidently translated from the Swart edition. The portion relating to New Zealand ended, unfortunately, with the massacre in Murderers' Bay. I do not know who the translator is, but his work has been done in the most competent and accomplished way, and it is to be hoped that he will complete it. The translation is sometimes not quite literal, and that in parts which would not be obscured by a literal rendering. Nor do I understand the principle adopted in giving the longitudes: these are not Tasman's, even with the data for corrections above given, nor are they the true longitudes. The distances run are given in English miles. So, then, all the previous renderings of Tasman's Journal prior to that of Jacob Swart in 1860 have been incorrect in various particulars, the chief one being that of excessive abridgment. As regards the bibliography of these, I cannot do better than refer to my paper in the "Transactions of the New Zealand Institute" for 1894, pages 619, 620.

In his edition Jacob Swart prefixes to the Journal a publication of all the documents relating to it. These are of considerable value and interest, and were discovered in the old foliants and letter-books of the company, presumably at the same time that the long-lost Journal was found and forwarded from Batavia to Amsterdam. They consist—first, of a letter from Governor Van Diemen and his Council to the Council of Seventeen at Amsterdam, apprising them of Tasman's departure on his important expedition; second, of a Letter of Instructions to Tasman and his chief officers; and, third, of other letters and papers giving an account of previous discoveries and directions, which it was no doubt thought important that Tasman should have with him. The Instructions are far too lengthy to lay before you here, but they testify most favourably to the wisdom and foresight of Governor Van Diemen and his Council in all matters relating to the geographical knowledge of the time, in fitting out the ships, in suggesting suitable measures in case of accident or failure, and generally in their

fullness of sagacious advice and command. Even to-day they would well serve as models to copy. The vessels of the expedition were two—the ship or yacht Heemskerck, and a smaller vessel, the flyboat Zeehaen, the former having a crew of sixty, the latter of fifty men. They were victualled for twelve months.

Towards the better understanding of the Journal, I would here explain that Tasman begins and ends his day at midnight—that is, it is the same as our civil day. He reckons his course and the distance run from noon to noon, at which time he took his latitude and longitude. His watches were —the day or morning watch, from 4 to 8; the forenoon or noon watch, from 8 to 12 noon; the afternoon watch, from 12 to 4; the flatfoot, or, as we call them, the dog watches, from 4 to 6 and 6 to 8; the first watch, 8 to 12 midnight; and the second or hound watch, 12 midnight to 4 in the morning. It is curious that of all Teutonic-speaking sailors the English alone use the term "dog-watch" as signifying the hours between 4 and 8 p.m. Other Teutons use the equivalent *hund-*, *hunde-*, or *honde-wacht*, as signifying the second watch—that between midnight and 4 a.m.; and to express their dog-watches, between 4 and 8 p.m., they use *plattfuss*, *plattfoden*, or *platvoet*, meaning "flatfoot." The neo-Latin or Italic speaking sailors had no such words as "dog-watch" or "flat-foot," but spoke of the second watch, or of the watch from 4 to 6 or 6 to 8 in the evening. I do not know the underlying meaning of these words, but can fancy they contain the idea of the most restful part of a ship's day, when a dog would be sufficient guard, and when any work on deck would be done without running—all heel and toe, as the pedestrians have it—a flat foot.

The vessels sailed from Batavia on the 14th August, 1642, with instructions to make in the first instance for the island Mauritius, where they were to take in fresh provisions and otherwise refit. At this time Mauritius belonged to the Dutch, and was a convenient recruiting-place for their vessels as they sailed to and fro between Holland and the Batavian settlement. Tasman commences thus: "Journal or description by me, Abel Jansz. Tasman, of a voyage made from the City of Batavia, in the East Indies, for making discoveries of the unknown South Land, in the year 1642, the 14th August. May God Almighty be pleased to give hereto His blessing. Amen." Mauritius, a distance of about 3,000 miles, was reached, after a splendid run for those days, on the 5th September. This would give an average of about 120 miles a day sailed. Here a month's stay was made, during which the vessels were thoroughly refitted, and pigs, goats, wild-fowl, firewood, and fresh water were brought on

board. Thus fortified at all points, they left Mauritius on the 8th October, "for which," says Tasman, "the Lord be praised and thanked." The course was now south and south-east. On the 27th a considerable quantity of weed was seen, which indicated proximity to land. A council was held, and it was determined to keep a man constantly at the topmast-head on the look-out, and whoever first discovered land, rocks, or shoals should be rewarded with three reals and an extra pot of arrack or rum. Nothing further, however, was seen for nearly a month, and until the 24th November, when Tasman made his first discovery, that of Van Diemen's Land, so called by him after his patron the Batavian Governor. The distance thus run from Mauritius was nearly 6,000 miles, the average daily run being about 140 miles. He named many of the bays and headlands—names retained to this day, such as Frederick Henry and Storm Bay, Maria Island, &c. He explored here until the 4th December, and saw at a distance some of the inhabitants, smoke rising in the woods, steps cut into the trees with flint axes, whereby the natives climbed up them to search for birds' nests; specimens of gum, and so on. Before leaving Van Diemen's Land, on the 5th December, a fort was erected in Frederick Henry Bay, with a flag flying on it. The vessels were again at sea on the 5th December. A council was called, when it was agreed that the course held should still be one due east, and that it should be kept for twenty-six degrees of further longitude; if no further land was fallen in with, a northerly course should be shaped for home. Eight days later, on the 13th December, Staten Land, or New Zealand, was discovered. As the distance run from Van Diemen's Land was about 1,000 miles, it is evident that the average sailing-rate of 125 miles a day had been still maintained.

It will save interruption in Tasman's narrative, and render it more intelligible, if at this point I preface a few further words of explanation. The land—"the great high land," as Tasman calls it—he would first see between Hokitika and Okarito; and it is not too fanciful to say that that great mountain which two hundred and fifty years later was called by his name was one of the first sights he saw on the wild west coast. Somewhat further north he describes that low point known to us as Captain Cook's Cape Foulwind, with its outlying steep rocks or cliffs, the Steeples. Westport is not far from this point. "North of this," as Tasman says, "the land makes a great bight": this is the Karamea Bight. Then came the "furthermost point, which stood out so boldly that we had no doubt it was the extreme point.' This is now Captain Cook's Cape Farewell, with

the long spit of sand running from it, upon which is a lighthouse. Next in order is that bay of tragic interest called by Tasman "Murderers'," but now known as Golden Bay, in which is the Township of Collingwood. The scene of tragedy lies close to Parapara, where at this moment a new and far different interest has arisen in the fact that a great and peaceful trade is expected to spring up in connection with the masses of hæmatite which lie around the shore. Thankfully escaping from this dreadful spot, Tasman tacked about in what he called "Zeehaen's Bay," but which in truth was the north-west portion of Cook Strait. As we shall presently see, Tasman himself suspected that there was a passage through. Proceeding north, Cape Egmont was seen, and was named Cabo Pieter Boreels, after one of the Dutch East Indian Council. No reference is made to the mountain. The high mountain seen on the 27th in lat. 38°, and taken at first for an island, would probably be Mount Karioi, bounded as it is to the north by Whaingaroa Harbour, and south by Kawhia and Aotea Harbours. The Three Kings Islands were Tasman's point of departure from New Zealand. This name was given from the fact that the vessels anchored there on the 5th January, the eve of the Epiphany. You may remember the incidents connected with this religious festival which commemorated the meeting of the three Magi or Wise Men of the East with the infant Christ. Their names were Kaspar, Melchior, and Balthasar. The fable says that their bones were removed to the cathedral at Cologne, where they still rest, and where, as in Tasman's time, they are still venerated by all faithful observers of old Christian legends. I may here remark that in all probability the interesting process of name-giving did not take place until after Tasman's return to Batavia. The best description of the Three Kings known to me is that given by Mr. Cheeseman, the curator of the Auckland Museum, in the volumes for 1887 and 1890 of the New Zealand Transactions. Mr. Cheeseman made many additions to our natural-history knowledge of these islands, and he also recognised that part of the Great King upon which Tasman's crew attempted to land when searching for water and vegetables. It is much to be regretted that Swart does not reproduce Tasman's sketches. In a provoking way he says that these are to be found in "Valentijn." Valentijn's abridged copy of the Journal was published in 1726, and to this rare work the reader is referred. It is to be hoped that this omission will be rectified in Müller's forthcoming edition. Tasman's intercourse with the natives was but of a few hours' duration; yet it was sufficiently long to enable him to give a personal description. It is, therefore, curious to find he makes no reference to the adornment of the tattoo.

Does this indicate its non-existence two hundred and fifty years ago? It is advisable to repeat here that Tasman's miles, which are Dutch, must be multiplied by four to reduce them to English measurement. Other explanatory comments will be found in the previous half of this paper.

### The Journal.

December 12th [1642].—Good weather, and the wind south-south-west and south-west, with a sharp breeze. At noon found the latitude 42° 38′, and longitude 185° 17′. Course held east, and sailed thirty-eight miles. The swell of the sea continued from the south-west, so that here no great land is to be expected to the south. Var. 7° north-easterly.

13th.—Found latitude 42° 10′, longitude 188° 28′. Course held east by north, and sailed thirty-six miles. The wind south-south-west, with a topsails' breeze. Towards noon we saw a great, high, bold land, and had it south-east from us about fifteen miles; we gave our course south-east, straight for it. About noon we fired a shot and hung out the white flag, whereupon the officers of the Zeehaen came aboard us, when it was resolved, all agreeing, to make for the said land as soon as possible, as the resolutions of this date further show. In the evening we thought it advisable to order our steersmen, as long as it remained calm, to hold the south-east course, but with increase of the breeze should go due east, so as to keep from going ashore, and to prevent any accident as far as possible. In our judgment, we should not attempt to land on this side, because of the great open sea which here with great rough billows and surf comes rolling in, unless there were some sheltered bays on this side. In the first watch, four glasses having run out [10 a.m.], we stood our course due east. Var., 7° 30′ north-easterly.

14th.—At noon found our latitude 42° 10′, and longitude 189° 3′; course held east, and sailed twelve miles. We were about two miles from the land. It was a very high, double land, but from the thick clouds we could not see the tops of the mountains. We shaped our course northerly, and so close that we could see the surf breaking on shore. In the afternoon, about two miles from shore, we sounded in 55 fathoms, sticky, sandy ground. It was calm. Towards evening we saw a low point, about three miles from us north-east by north. We drifted quietly towards it. In the middle of the afternoon we sounded in 25 fathoms, sticky, sandy ground. We sailed along quietly the whole night, the current setting in from the west-north-west. We neared the land till within 28 fathoms, good anchor-ground; it still being

calm, and not to go nearer the land we anchored in the dog-watch [4 to 8 a.m.] with a stream-anchor, and waited for the land-wind.

15th.—In the morning, a light land-breeze. We weighed anchor, and did our best to get off the land a little to sea. Course north-west by north. We then had the northerly low point of the day before north-north-east and north-east by north from us. This land consists of high, double mountains, not lower than Formoza Island. At noon found latitude 41° 40′ and longitude 189° 49′. Course held north-north-east, and sailed eight miles. The point of the previous day lay south-east from us. Two and a half miles from this point stretches north a large reef. Here, above water, on this reef some high, steep cliffs, like steeples or sails. Past this point, moreover, a mile to west, there was no bottom. From here also we saw the high land stretch north-north-east from us. We set our course due north, with fine, dry weather and slack water. From this aforesaid low point, with the cliffs, to the north-east the land makes a great bight, and stretches first due east and then again due northerly. This aforenamed point lies under the southern latitude of 41° 50′. The wind west. Here it was easy to see that in this country to the water it seemed a barren land. Besides, we saw no men nor any smoke in the least, and we also saw that they could have no boats there, as we could see no signs of them. In the evening, var. 8° north-easterly.

16th.—Six glasses before the day [2.30 a.m.] we sounded at 60 fathoms, good anchor-ground. At that time the northerly point in sight lay north-east by east from us three miles, and the nearest land from us lay south-east a mile and a half. We drifted in the calm, with good weather and still water. At noon got latitude 40° 58′, and longitude 189° 54′; course held north-north-east, and sailed eleven miles. Drifted through the calm all afternoon. In the evening, at sunset, var. 9° 23′ north-easterly. Got the wind south-west, with increasing breeze. We took the bearing of the furthermost point from us we could see, which was east by north from us. It stood out so boldly that we had no doubt it was the extreme point. We called our council, with the second mates, whereupon we resolved to go north-east and east-north-east to the end of the first watch [8 to 12 p.m.], and then, weather and wind not changing, to sail near the wind, as is further to be seen by the resolution of this date. At night, at the sixth glass [11 p.m. (?)], the weather became calm, so that we remained by the east-north-east course, although in the fifth glass of the dog-watch [second watch, 2.30 a.m.] the point of the previous evening lay south-east of us. From the sharpness

of the wind we could sail no higher than east-north-east a trifle east. In the first watch [8–12 p.m.] we had one, and in the dog-watch [second watch, 12–4 a.m.] another, sounding in 60 fathoms: fine grey sand. In the second glass of the morning watch [4–8 a.m., say 5 o'clock] we got a breeze from the south-east, and we then tacked again for the shore.

17th.—In the morning at sunrise we were about a mile from the land. We saw in different places smoke rising where fire had been made by the inhabitants. The wind, south from the land, went round to the eastward. At noon we worked out the latitude 40° 32′, longitude 190° 47′. We held a course north-east by east, and sailed twelve miles. In the afternoon, wind west, course east by south along a low sand-hill shore, with fine, dry weather. Soundings, 30 fathoms, black sand; so that by night we might easily sound along the ground to this shore. So we ran towards this sand-point up to 17 fathoms, where, because of the calm, we anchored at sundown. We then had the northernmost of the dry sand point west by north from us, also high land stretching east by south, and the point of the reef south-east from us. Within this narrow point of sand we saw a large, open bay, quite four to three miles wide. East of this narrow sand-point there is a sand-bank which stretches quite a mile east-south-east, 6ft., 7ft., and 8ft. to 9ft. deep. In the evening, 9° north-easterly [variation].

18th.—In the morning weighed anchor, with calm weather. At noon, latitude worked out 40° 49′, longitude 191° 41′. Course held east-south-east, and sailed eleven miles. In the morning, before weighing anchor, we had resolved with the officers of the Zeehaen that we should endeavour to land and find a convenient harbour, and when near shore should send the shallop in advance, as is further amplified in the resolution of this date. In the afternoon our shipmaster, Ide Tiercxsz, and pilot-major, Francoys Jacobsz, with the shallop, besides the Zeehaen's boat with the supercargo Gilsemans and one of their second mates, went on before to seek for an anchorage and watering-place. At sunset, it being calm, we anchored in 15 fathoms, good holding-ground. In the evening, about an hour after sundown, we saw several lights on the land, and four boats along the shore, of which two came towards us, and the other two—our own—returned on board. They reported that they had found not less than 13 fathoms water, and that they had been about half a mile from the shore at the setting of the sun (which sank behind the high land). About one glass after they had returned on board the people in the two prows began to call to us, and that with a coarse, rough voice, but we could not understand in the

least what they said. However, we called to them again in answer, whereupon they cried again several times, but came no nearer than a stoneshot. They also repeatedly blew on an instrument which was like a Moorish trumpet. We let one of our sailors (the one who could play on the trumpet) play some pieces in answer. Those on the Zeehaen made their second mate do the same. (He had formerly been a trumpeter on shore, and had been made at Mauritius a second mate by the Council of the Port and Shipping). After this had been repeated on both sides several times, and as the evening shade was falling more and more, those in the boats finally cleared and went away. We ordered our people (for security, and to be well on guard) to keep entire quarterly watch (as is usual at sea), and that the munitions of war, such as muskets, pikes, and cutlasses, should be got ready. We let off some pieces on the top deck and reloaded, so that all accidents might be forestalled and we might defend ourselves in case these people might attempt anything. Var., 9° north-easterly.

19th.—This morning early a boat of these people, having thirteen men, came about a cast away from our ship. They called out several times, which we could not understand, the speech having no resemblance to the vocabulary given to us by their Highnesses the Governor-General and Council of India. But this is not to be wondered at, as it was the language of the Salomon Island. These people were (so far as we could see) of ordinary height, but coarse of voice and strong, their colour between brown and yellow. They had black hair, fast bound right up on the crown of their heads, in manner and fashion of the Japanese on their heads, but with a long, thick tuft of hair in which was stuck a large, thick white feather. Their boats were two long narrow prows fastened together, over which were placed some boards or other seats, so that those above can see through the water under the canoes; their paddles were a full fathom long, and sharp at the end. With these boats they could obtain great speed. Their clothing (so it appeared) was some of mats, others of cotton, whilst most were naked to the waist. We pointed out to them many times that they should come on board, showing white linen and some knives from those given us in our cargo. But instead of coming nearer they returned at last to shore. Meanwhile the officers of the Zeehaen came on board us (by order of the previous evening), and a council was held, when it was resolved to go as near shore as we could, as there was good anchorage, and these people (as it seemed) sought our friendship. Soon after taking this resolution we saw another seven boats come from the shore, whereof one (high in front, and pointed), manned with seventeen men, pulled behind the

Zeehaen, and a second (wherein were thirteen stout men) came up not half a cast from our ship, who called to each other several times. We showed them (as before) white linen, &c., yet they remained still. The master of the Zeehaen sent his quartermaster with his boat and six sailors back to the ship, to direct the mate, in case these people should come alongside, not to allow too many on board, but to be prudent, and well on his guard. Just as the Zeehaen's boat put off, the natives in the nearest prow to us called out and signalled with their paddles to those who were behind the Zeehaen, but what their meaning was we could not understand. Just as the Zeehaen's boat pushed off again, that one lying between the two ships began to pull furiously towards it, and when about half-way from us struck the Zeehaen's boat furiously with their stems, making it lurch greatly at the same time; whereupon the foremost man in this villainous prow thrust the quartermaster, Cornelis Joppen, several times fiercely in the neck with a long, blunt pike, so that he fell overboard. Whereupon the others of them attacked the boat's crew with short, thick pieces of wood (which we at first took to be blunt parangs) [a kind of chopping-knife used by the Malays for cutting wood, &c.] and with their paddles, and overcame the boat, in which fray three of the Zeehaen's people were killed and a fourth mortally wounded through hard blows. The quartermaster and two sailors swam towards our ship, and we sent our shallop to them and picked them up alive. After this outrageous and detestable affair the murderers let the boat drift. They had one of the dead dragged into their prow, and another drowned. We, and those on the Zeehaen, seeing this, shot briskly with muskets and cannon, but, however, probably did not hit any, as both returned to shore out of shot. We fired many shots from our fore-upper-deck and bow guns near and amongst their boats, but did not strike. Our master, Ide Tercxsen Holman, rowed with our shallop, well manned and armed, to bring back the Zeehaen's boat (which, luckily, these cursed men had let drift), and presently returned on board with it, finding in it one of the dead and one mortally wounded. We weighed anchor and got under sail, as we judged we could not establish any friendship with this people, nor could get water or refreshments. Our anchors weighed, and being under sail, we saw twenty-two prows alongshore, whereof eleven, swarming with men, came off to us. We kept quiet until some of the first were within shot, when with our pieces we fired one or two shots from the gunners' room, but without effect. The Zeehaen fired too, and hit, in the largest prow, one who stood with a white flag in his hand, so that he fell down. We also heard the grape-

shot strike in and against the prow, but what further happened is unknown to us, as after getting this shot they returned speedily to land, two of them setting up sails fashioned like tinganghs [a Malay boat: our "dingy" is derived from this]. They remained quiet alongshore without visiting us again. About noon the master, Gerrit Jansz, and Sr. Gilsemans again came on board us. We sent also for their chief mate, when we called the council, and resolved as follows: That the detestable deed of these natives that morning on four of the Zeehaen's men should teach us to hold the inhabitants of this land as enemies; that we shall therefore keep easterly along the shore, following the coast-line, to see if we can find a convenient spot to obtain water and refreshments, as is further mentioned in the resolutions. At this place of murderers (to which, moreover, we have given the name of Murderers' Bay) we lay anchored in south latitude 40° 50′, longitude 191° 30′. We steered our course from here east-north-east. At noon reckoned latitude 40° 57′, longitude 191° 41′. Held a southerly course, and sailed two miles. In the afternoon the wind was from west-north-west. We then steered, on the advice of our steersmen, and our approbation, north-east by north. At night we went on, as the weather was fine; but about an hour after midnight we had soundings in 25 to 26 fathoms; hard, sandy ground. Soon after the wind was north-west. Had soundings in 15 fathoms. We immediately steered our course west, in the contrary direction from that by which we had entered, awaiting the day. Var., 9° 30′ north-easterly. This is the second land sailed about and discovered by us. We have given it the name of Statenlandt, in honour of their High Mightinesses the States-General. Thus it is possible that this land is part of the great Statelandt, but it is uncertain. This same land seems to be a very fine country, and we trust that it is part of the great coast of the unknown Zuytlandt (South Land). We have given this course the name of Abel Tasman course, because he is the first to navigate it.

[In this place, in Tasman's Journal, are found the drawings of the plates which Valentijn has given us on pp. 49, &c., under No. 6F, No. 5E, No. 5EB, and No. 7G. The plate No. 6F is not so complete as that of the manuscript journal. The reader, of course, knows that the name of Staten-land has since been changed to that of New Zealand, and it consists of two large islands, which are separated by a strait or passage now named Cook Strait. It was in the opening to the westerly entrance of this strait that Tasman lay anchored with his two ships when the New-Zealanders, without the slightest warning, fell upon his shallops, wherefore in the account he named that part Murderers' Bay. That portion

of the sea found between the islands of Van Diemen's Land and New Zealand was named by him Tasman's Track, a name which remains to this day, and serves to remind us all of that brave man who was the first to sail round New Holland, and to accomplish the voyage between New Holland and New Zealand.—Jacob Swart.]

20th.—This morning we saw land lying all around us, so that we have sailed perhaps thirty miles into a bay. We had at first thought that the land where we anchored was an island, not doubting that we should find a passage into the great South Sea. But to our great disappointment it proved otherwise. The wind being westerly, we endeavoured to get back through the same passage by which we had before sailed in. At noon found ourselves in south latitude 40° 51′, and longitude 192° 55′. We held our course east-half-north and sailed fourteen miles. In the afternoon it was calm; the sea ran strong into the bay, so that we could not advance, but drifted back with the tide. At noon we turned northwards and saw a round, high island* about eight miles from us west by north, which we had sailed by the previous day. This little island lies about six miles east of the place where we were anchored. In the same latitude in this bay, into which we had sailed so far by mistake, the land seemed everywhere fine and good: on the sea-coast low, barren land; moderately high inland. Sailing along the coast there is anchorage from 60 to 50 fathoms to 15 fathoms, becoming dry about a mile and a half to two miles from the shore. At 3 in the afternoon got light breezes from the south-east, but, as the sea ran very rough, we made but little or no progress. In the night we drifted along calmly; in the second watch [12–4 a.m.] the wind was west, going round to the northwards.

21st.—At night in the dog-watch [12–4] had a westerly wind with a strong breeze. Steered to the north, in the hope that the land, which the day before was north-west from us, should there fall away to the north, but it extended to the north-west. After the cook had dished we tacked and turned again from the land. It began to blow stronger, so we ran south-west over towards the south shore. At noon found latitude 40° 31′ and longitude 192° 55′. Held a northerly course, and sailed five miles. It was foggy, so that we could see no land. Late in the afternoon again saw the south coast, and had the island, which the day before was about six miles west from us, about four miles south-west by south. We sailed towards it, bringing it to bear north-north-west from us, and anchored by some cliffs in 33 fathoms, sandy ground, mixed with shells. Here it is full of islands and rocks. We struck our sail-yards,

* Stephen Island.

for a storm threatened from the north-west and west-north-west.

22nd.—Wind north-west by north, and blowing so hard that there was no appearance of going on under sail, and it was difficult enough for the anchor to hold. We made our ship snug. We here lay in south latitude 40° 50′ and longitude 192° 37′. Course held south-west by south, and sailed six miles. At night we got the wind so hard from the north-west that we struck the topmasts and let go another anchor. The *Zeehaen* did the same.

23rd.—Still dark, foggy, drizzling weather, the wind north-west to west-north-west, and that with such a storm that to our great regret we could not advance.

24th.—Still hard, unsteady weather; the wind still north-west, and stormy. In the morning had a calm interval. Hoisted a white flag and got the officers of the *Zeehaen* on board us, and it was proposed that, as the flood came from the south-east, there might probably be a passage through, and whether it would not be best, wind and weather permitting, to search for this, and to see if we could not get fresh water there: as may further be seen by the resolutions drawn up thereupon.

25th.—In the morning we reset our topmast and yards, but it still looked so gloomy that we dare not lift anchor. Towards the evening it became calmer, so that a portion of our cable was shortened.

26th.—In the morning, two hours before day, we got the wind east-north-east, a light breeze. We weighed anchor, got under sail, and steered towards the north, intending to sail northward by this land. With the day it began to rain, and the wind went round to the south-east, and then south to south-west with a stiff breeze. Had soundings in 60 fathoms. We set our course by the wind to the west. At noon, latitude 40° 13′, longitude 192° 7′. Held a north-north-west course, and sailed ten miles. Var., 8° 40′. At night lay-to with easy sail.

27th.—In the morning made sail at daybreak, and steered north; the wind south-west, with a strong breeze. At noon found latitude 38° 38′, and longitude 190° 15′. Course held north-west, and sailed twenty-six miles. Set our course at noon north-east. At night lay-to, with little sail. Var., 8° 20′.

28th.—In the morning made sail at daybreak; set our course to the east, so as to get sight of the land which we had previously seen in 40°; it stretched still further to the north, and then to the east. At noon we saw, east by north from us, a high mountain. We took it at first to be an island, but afterwards saw it was part of the mainland. We were

about five miles from shore. We threw the lead in 50 fathoms, fine sand mixed with clay. This high mountain [Mount Karioi ?] lies in south latitude 38°. This coast stretches, so far as I could see, south and north. It became calm, with a light air from north-north-east; we tacked to the north-west. At noon anchored, latitude 38° 2′ and longitude 192° 23′. Course held north-east by east, and sailed sixteen miles. Towards evening the wind came north-east and north-east by east, and began to blow harder and harder, so that at the end of the first watch [8–12 p.m.] we had to take in our topsails. Var., 8° 30′.

29th.—In the morning, at daybreak, we took off our bonnet-sails [small sails beneath the foresail], so that we had to take in our foretopsails. At noon we computed the latitude to be 37° 17′ and longitude 191°, and we ran over to the westward. Course held north-west, and sailed sixteen miles.

30th.—In the morning the weather was something more moderate. We set our topsails, rigged our bonnet-sails. Had the Zeehaen to lee of us. Wind west-north-west, with a topsails breeze. At nocn found the latitude 37° and longitude 191° 55′. Course held north-east, and sailed seven miles. Towards evening again saw the land north-east and north-north-east from us. We therefore ran north and north-east. Var., 8° 40′ north-easterly. [Tasman here gives two sketches of the Staten-land (New Zealand)—first, as it appeared in 38° 30′ south latitude, and second, in 36° south latitude.—Jacob Swart.]

31st.—At noon we tacked about to the north, and the wind west-north-west, a slack breeze. Noon, found latitude 36° 45′, and longitude 191° 46′. Course held north-west, and sailed seven miles. In the evening we were about three miles from the shore. Four glasses of the first watch [10 p m.], again tacked to the north. In the night sounded in 80 fathoms. This coast here stretches south-east and north-west. The land is in some places high, and in others sandhills. Var., 8°.

January 1st [1643].—In the morning drifted in the calm along this coast, which here stretches north-west and south-east. It is an even coast, without shoals or sandbanks. At noon had latitude 36° 12′, and longitude 191° 7′. Course held north-west, and sailed ten miles. About noon the wind came south-south-east and south-east. We steered our course west-north-west to be further off shore, and here a heavy surf was running. Var., 8° 30′ north-easterly.

2nd.—Calm weather. In the middle of the afternoon a breeze came from the east. We steered north-north-west at the end of the first watch [12 p.m.], course north-west, so as not to come too near shore, and to avoid any accident, as in

the evening we had the land north-north-west from us. At noon, latitude 35° 55′, and longitude 190° 47′. Course held north-west to west, and sailed seven miles. Var., 9°.

3rd.—In the morning saw the land about six miles from us east by north, and were astonished to find ourselves so far from shore. At noon found latitude 35° 20′, longitude 190° 17′. Course held north-west to north, and sailed eleven miles. At noon got the wind south-south-east, and steered our course east-north-east, so as to run again towards the shore. In the evening we had the land north and east-south-east from us.

4th.—In the morning we were near a cape, and had an island north-west by north from us, whereupon we hoisted the white flag for the officers of the Zeehaen to come aboard us, and resolved with each other to stand for the said island and see if we could not get there fresh water, vegetables, &c. At noon found latitude 34° 35′, longitude 191° 9′. Course held north-east, and sailed fifteen miles; the wind south-east. Towards noon we sailed calmly. We found ourselves here in a very strong current, setting us to the west. There was also a heavy sea drawing from the north-east, which gave us not a little hope that there might be a passage here. We had this point east-north-east from us lying in south latitude 34° 30′. The land here fell away to the east. In the evening the pilot-major, with the secretary of the Zeehaen, went close by the island, and could not observe that what we wanted was to be had there. Agreed with the officers of the Zeehaen that if we got a good wind in the night it would be best to go on. Var., 8° 40′ north-easterly. [Here is found in the manuscript the chart and representation of No. 8H and No. 9J, but without the ships, which Valentijn added here to give a little adornment.—Jacob Swart.]

5th.—This morning still drifted in the calm, but about 9 o'clock had a light breeze from the south-east. We agreed with our friends of the Zeehaen to steer for the island. About noon we sent our shallop with the pilot-major, and the Zeehaen's boat with Gilsemans, the supercargo, to inspect the island, and see if water was to be had there. In the evening they returned on board and reported that they had gone close to land, being always on the watch that none of the natives should fall upon them, and had entered a small, safe bay, where fine fresh water was found, which fell from steep hills in great abundance; but, from the surf on the shore, it was dangerous and troublesome to water there; so they rowed further round the island, seeking if they could find any other convenient place. On this land in various places, and on the highest hills, were about thirty to thirty-five

persons, men of tall stature, so far as they could see, with staves or clubs, who called to them in gruff, loud voices which they could not understand. In walking they took great steps and strides. In rowing round they saw a few more people on the hills, whereupon they resolved (as may well be believed) to be well on their guard, and to hold their boats and small weapons in readiness. On this island they reckoned there would not be more people than had shown themselves, for on rowing round our people saw no dwellings, nor cultivated land except that near the fresh water. Here, on both sides of the waterfall, there were everywhere square enclosures after the manner of our country, green and pleasant. But what kind of vegetables they could not tell from the distance. It was quite possible their dwelling-places were round here on account of the fresh water. In this aforesaid bay there were two prows lying, hauled upon shore—one navigable, the other broken. They saw no other boats anywhere. Our people then returned. We immediately endeavoured to get under the land, and about evening anchored a short pedereroe [a piece for firing stones and gravel] shot from shore in good ground. We at once made preparations for taking in water next day. The island lies in south latitude 34° 25′, and longitude 190° 40′.

6th.—At early morning we sent both boats—to wit, ours and the Zeehaen's—to the watering-place with casks to get water. Each one mounted with two pedereroes, six musketeers. The rowers had pikes and side-weapons. With one shallop were Pilot-major Francoys Jacobsz, and the master, Gerrit Jansz. As they rowed towards the land they saw, standing in different places on the heights, big men, each with a long stick like a pike, who seemed to be watching us, and, as our people passed by, called loudly to them. But when they had got about half-way to the watering-place, between a safe point and another great high crag or little islet, the current ran so strongly against the wind that the boats could scarcely stem it; whereupon the pilot-major and Gerrit Jansz, master of the Zeehaen, with the other officers, held counsel, resolving not to imperil the boats and men, as they had a long voyage before them, and the ships could not afford their loss; and so they returned on board, the more so as a heavy surf was rolling on the land near where the watering-place was, and, the breeze beginning to increase, they would have found it difficult to reach land. We signalled from our ship by hoist-the flag and firing a cannon that they should come back; but they were then near us, and seen to approach. The pilot-major, with our boats, came on board, reporting that, from the wind and the innumerable hard rocks all around, without any sandy ground, it was too dangerous, and they would be subject to the peril of being attacked by the natives, and of having

the water-casks injured and broken to pieces. We immediately ordered the officers of the Zeehaen and the second mates to come aboard us, when we summoned the council, and resolved to lift the anchors, and with an easterly course to run to latitude 22°. Following the foregoing resolution, that we should keep due north to south latitude 17°, and then should steer a due-west course, and run straight in right on the Coques [Cocos] and Hoorense [Horne] Islands, and there obtain water and refreshments; or, if we should earlier come upon any other island, that we should endeavour to do the same there: as is specified in the resolution of this date, lately referred to. Near noon we got under sail, having the island at noon about three miles from us due south. In the evening, at sunset, it was six to seven miles south-south-west from us, the rocks and the island lying south-west and north-east from each other. At night, pretty calm, wind east-south-east. Held our course by the wind north-north-east, the sea running from the north-east.

Such, then, is the entire and literal translation of that part of Tasman's Journal which relates to his discovery of New Zealand. Time forbids that I should give more than the briefest account of his continued voyage, which is full of interest. Steering north-east, he discovered in succession Pylstaart, now Tropic-bird Island, where are found those birds (*Phaethon rubricauda*), which occasionally make for the very north of New Zealand, and whose tail-feathers are so highly prized by the Maoris as an ornament for the hair; then three islands of the Tongan Group—Tongatabu, Anamoka, and Eoa—which he called Amsterdam, Rotterdam, and Middelburg. The stay in this group was lengthy and grateful, and made some amends for the inhospitable reception in New Zealand. Here fruit, water, and provisions were procured in abundance from the friendly natives. On the 6th of February Prince Willem's Islands—the Fijis—were discovered. The general course then maintained was west-north-west. Several islands were passed, and the coast of New Guinea reached on the 14th April. For more than a month he sailed along the northern coast, and gives an exceedingly interesting description of the country and natives. Well-recognised points and islands were then fallen in with, and on the 15th June, 1643, the vessels dropped anchor at Batavia, after an absence of two years save two months. "God be praised and thanked for a safe voyage. Amen!" is Tasman's last entry. His Journal is written in a plain, quaint, intelligible style, and abundantly shows that the writer was a bold and accomplished seaman as well as a fortunate discoverer.

In 1644 he was again despatched to examine the north coast of New Holland, and to explore what is known to-day as Torres Straits. The papers connected with this important exploration have never, so far, been discovered. But the painstaking research made of late years into various departments of long-forgotten history may yet succeed in giving us another and Tasman's last Journal. Proud of the discoveries of their countrymen, which were enriched so specially by those of Tasman, the Dutch sought to perpetuate them in imperishable marble. In 1648 they erected at Amsterdam their magnificent Stadhuis or Town Hall. Part of the embellishments consisted of a map of the world, projected as a planisphere and deeply cut into the stone floor. Each of the hemispheres was 22ft. in diameter, and they contained all that had been discovered of New Holland, Van Diemen's Land, and New Zealand. But the traffic of thousands of feet finally effaced this curious map, and when, in 1773, Sir Joseph Banks visited Amsterdam no trace of it remained, nor had the oldest inhabitant any personal knowledge of it. Fortunately, M. Thevenot copied the most material portion, and this appears in his "Divers Voyages Curieuses," Paris, 1663. It is also found in an old British Museum map, and in outline in Janssen's "Atlas," 1650. The labour of preparing this account of Tasman and his work is amply rewarded in laying it before an audience which on so many previous occasions has granted me a patient hearing. If it should reach the hands of those whose business it is to traverse our west coast, I hope they may be interested in comparing the details of their own log with those of an old seaman of two hundred and fifty years ago.

[Since this paper was written I have corresponded with Messrs. Frederik Müller and Co., of Amsterdam, who are preparing for publication the *édition de luxe* of Tasman's Journal above referred to. They say, "The papers of the Dutch East India Company are now in the Hague State archives. A journal of the 1644 voyage was never found, only the binding wherein it had been bound once was found by the old Mr. Frederik Müller in the State archives some twenty-five or thirty years ago."—T. M. H.]

## ART. XVI.—*On an Account of a Massacre at the Entrance of Dunedin Harbour in the Year 1817.*

By A. HAMILTON.

[*Read before the Otago Institute, 11th June, 1895.*]

Plate II.

IN searching the old files of the *Otago Witness* for 1858 I came across the following account of a massacre at the Otago Heads, at the entrance to Dunedin Harbour, or, as the account calls it, "Port Daniel." Though evidently written in a guarded manner, the narrative appeared to me to be probably founded on fact, and I therefore made inquiry into the matter, to obtain, if possible, corroborative evidence. The scene of the episode is called "Port Daniel, a place only known to Europeans within the last seven years." I made many inquiries from old residents, but cannot hear that this name was ever given to the harbour, nor does it appear on any of the old charts or plans. The usual name for the inlet appears to have been "the River." I then made inquiries in Tasmania, through the librarian of the public library, Mr. Taylor, and he very kindly sent me a copy of the original article as it appears in the files of the Hobart paper, agreeing in every respect with that in the *Witness*. He also gave me the references to the shipping news of that date, in which the "Sophia" cleared for New Zealand on the given date, and also the date of her return. He said that the ship and her owners were well known, and that he had every reason to believe that the account given was a correct one. It may be mentioned that Mr. Kelly was the man who made an adventurous voyage round Tasmania in an open boat in the year 1815.

The extract from the *Otago Witness** is as follows:—

"ADVENTURE AT OTAGO FORTY YEARS AGO.

"(From the Hobart Town *Courier*.)

"The 'Old Stager' has handed to us a narrative of events that happened to him on the south-east coast of New Zealand, part of which was published on his return to the port in Bent's *Hobart Town Gazette and Southern Reporter* of 28th March, 1818. Full details of the narrative were not furnished, but now for the first time are completed from his 'ancient log.' Port Daniel, where the scene of the adven-

* 21st August, 1858.

ture is laid, is now better known as the peaceful settlement of Otago; the reader will therefore read 'Otago' for 'Daniel.' The 'Sophia' (Mr. James Kelly, master) sailed from Hobart Town on the 12th November, 1817, on a sealing voyage, and anchored at Port Daniel, on the south-east side of the southern part of New Zealand, on the 11th December (a place only known to Europeans within the last seven years). The master, Mr. Kelly, with his boat's crew, went on shore the same day, and met with a friendly reception from the natives, which they attributed to the knowledge the latter had of one of the crew, named W. Tucker, who had been well treated by them, and engaged their apparent friendship on former visits, and who was called by these people 'Wioree.' On the following day Mr. Kelly went in his boat with six men (amongst them Tucker) to Small Bay,* outside of the harbour's mouth, and distant from the vessel about two miles. The natives here also received them kindly, and to them Tucker appeared equally well known, being challenged generally by name, 'Wioree.'

"Mr. Kelly made the chief of the village a small present of iron, and proceeded to his dwelling to barter for potatoes,† leaving one man to look after the boat. On reaching the house of the chief Mr. Kelly was saluted by a Lascar, who told him that he had been left there by the brig 'Matilda,' Captain Fowler. During a long conversation Mr. Kelly inquired after a boat's crew that was said to have been lost near Port Daniel, and learned that Brown, who had charge of the boat, with six men, had been killed and eaten by the natives. The Lascar then offered his services in bartering for potatoes for the vessel, and appeared familiar with the native tongue.

"By this time a great number of natives had assembled in the village, about sixty of whom were in the yard of the chief's house, where the boat's crew were standing. In an instant a horrid yell was raised by the natives, when Mr. Kelly, John Griffiths, and Veto Viole were thrown down by the mob.

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* I am inclined to think the "Small Bay" must be the smallest of the three bays on the north side of the Heads, now called "Murdering Beach" (Whareakeake). Mr. F. R. Chapman, who has a most intimate knowledge of the topographical features of the coast-line, doubts this, and would be inclined to fix one of the small beaches on the south side of the Heads.

† Potatoes. De Surville was, with Cook, supposed to have been the introducer of the potato to the Maoris of the North Island and the northern part of the South Island. Many old Maoris contend that *tiwas* were known and largely cultivated before the advent of Europeans. The Maoris certainly had a number of named varieties as early as 1820, and here we find them in Otago in 1817 able to supply large quantities to whalers as a recognised article of trade.

Tucker, with the remaining two (Dutton and Wallon) were also seized, but got out of the mob and ran to the boat, where they found the man Robinson, who had charge, reeling on the beach from a wound in the head. Thinking it impossible that any of the rest could escape, they immediately launched the boat. In the meantime Mr. Kelly was engaged in a dreadful contest with the natives, and, luckily having about him a new billhook, he miraculously effected his escape, being only speared through the left hand, after wounding his principal opponent on the head. In escaping through the gate of the yard Mr. Kelly saw Veto lying on the ground, but did not see Griffiths any more. The feelings of Mr. Kelly on reaching the beach under such circumstances, at the moment of the boat being launched, may be better conceived than described. Tucker was still on the beach. Dutton, Wallon, and Robinson were in the boat, backing her out of the surf. Mr. Kelly made the boat, and was dragged by her through the surf, calling on Tucker to follow, who, however, would not attempt to do so till too late, a number of savages immediately rushing down on the beach armed with spears and hatchets. Tucker kept calling to them not to hurt Wioree, but, regardless of his entreaties, he was speared in the right thigh by the man whom Mr. Kelly had wounded on the head, and who was then covered with blood, and immediately knocked down in the surf, where Mr. Kelly and his three men in the boat saw the unhappy Wioree cut limb from limb and carried away by the savages, having only had time to utter, 'Captain Kelly, for God's sake, don't leave me.'

"Mr. Kelly and his three men before mentioned now returned to his vessel, and found on board a number of natives of the village they had first visited on the previous day. Those natives, on Mr. Kelly getting on board the brig, pretended to be very friendly and asked what had become of Tucker, Griffiths, and Peter Viole, as they missed them out of the boat. On being told that they were killed by the natives on the opposite side of the river, and that Mr. Kelly and Robinson were wounded, they became very much excited (there being at the time about a hundred and fifty natives on board, the decks, rigging, tops, and yards were full of them). Mr. Kirk, the mate of the brig, said to Mr. Kelly, 'They are going to take the vessel from us.' Mr. Kelly immediately called all his men to quarters, and formed a solid square on the quarterdeck under the main boom. Their head chief, whose name was Corockar,* called to his men to

* Corockar = Karaka. There have been several chiefs of this name amongst the Maoris of this part. The present Maoris seem to know something of this or a similar incident, but are not clear as to the localities.

make the attack and seize us man to man. The natives stood so close around us that they could not make use of the weapons that they had in their hands; neither could we use our firearms, as we stood so close together. There was now only one chance left for us. We were all sealers on a sealing voyage, and each man kept two large sealing-knives slung by his side. Seeing that there was no alternative, Mr. Kelly called to his men to draw their knives and cut away, which had the desired effect. The natives began to fall so fast before the knives that a great number jumped overboard and were drowned, and many were swept out to sea by the strong ebb tide that was then running, and no chance of their getting on shore, as the tide was running five to six knots on the ebb.

"The gallant chief Corockar, seeing that his men were completely defeated, made a desperate attempt to kill one of our men with a tomahawk, but was seized by his arms, thrown down in the cabin, and locked up in the store-room till next morning. We then threw overboard sixteen bodies that were killed by the knives. The number who jumped overboard and were drowned must have been about fifty, and as many were wounded in the fight. We were fortunate, however, to find that only two of our men were slightly wounded in the affray. After cleaning up and washing down the decks, we sat down and congratulated each other on the very narrow escape we had from being taken and murdered by these savages.

"We kept a good watch during the night, in case of being attacked by a large number of canoes that were laying on the beach in front of the town. The next morning about 6 o'clock a large number of natives were gathered round the canoes. We expected that they were going to make an attack on the brig, and that they thought their chief Corockar was killed: they cried out often for him to come on shore.

"We tied his hands and let him come on deck. When they saw him there was great rejoicing. He called to them to bring a large canoe-load of potatoes alongside, to pay us, as we thought, for his liberation. A canoe was launched off the beach, with two men to paddle her off to the brig. On the canoe nearing the vessel, one of the men that was stationed aft called out 'The canoe is full of men!' We all rushed aft, and saw the canoe had a large number of men lying in her bottom covered over with mats. Our firearms being all ready loaded, lying on the deck, we lifted them and fired a volley into her. The natives, who were all armed with short spears and clubs, jumped over the sides of the canoe, and tried to pull it alongside the brig. Had they succeeded, they must have boarded and taken the vessel in spite of all that we could do. There were nearly forty of them, and only fourteen

in all of our crew. Several of them were shot and run through with boarding-pikes in trying to get up the sides of the vessel. Corockar jumped overboard to get to the canoe, but was shot in the neck. Two of his men swam to him and took him on shore in a most gallant manner, but he died next morning of his wounds. Thus we had another narrow escape of being taken and murdered. We kept a good watch all night, expecting to be boarded and taken at daylight.

"Next morning, being the 24th of December, 1817, a great number of natives were on the beach making a great noise, seemingly lamenting and crying because of the death of their chief Corockar. They were preparing to launch their canoes. We thought they were coming off to try and take the brig, and thought it better to stop them if possible. We immediately manned our two boats, and, taking arms and ammunition, pulled close to the beach where the canoes were lying. It was thought most expedient to destroy all their navy at once, to prevent them from making the attempt. As soon as the boats came near the beach the natives all ran away over the bank. We landed one boat's crew, and kept the other boat afloat to cover the men on the beach with their muskets. We then commenced with two long cross-cut saws cutting the canoes up, each into three pieces. They were forty-two in number, large and small, all of which we destroyed, and, as we wanted firewood, we split them up and took them on board. As soon as they saw all the canoes destroyed they rushed with clubs and spears up to their necks into the water trying to get hold of the boats, but they did not succeed in wounding any of our men.

"They having become more excited and inflexible at this attempt to seize our boats, we determined at once to land, set fire to the town and burn it to the ground. This was the 26th of December, 1817. It was a fine, clear summer day, blowing a fresh, hot wind from the north-west. We landed nine men, but kept the boats afloat. On our approach the natives all ran to the rising hills, and left us in full possession of the town. This town consisted of about six hundred fine houses, and perhaps a finer town never was seen in any part of New Zealand. The fire was lighted at the weather end, and in about four hours the beautiful City of Otago, as we then called it, was laid in a heap of ashes. We now required fresh water for our sea stock. There were several fresh-water holes on the beach where the canoes were lying. We observed the water in those holes of a curious colour, and recollected that Tucker had told us the natives were in the habit of poisoning the water if they expected their enemies were coming to invade them. This poisoning was done with a

large blue berry,* broken up and thrown into the water, which had the effect of poisoning both man and animal that drank of it. On this information from Tucker we declined taking or using any of the water. On the 27th December, 1817, at daylight, we weighed our anchor and left Port Otago, and sailed for Chatham Island. Hundreds of natives came down on the shore to see us off. We fired a volley of musketry towards them to say 'Good-bye.'

"We have little to add to the narrative. Captain Kelly regrets having listened to the persuasions of Tucker and the wish of the other men to go on shore the second day without firearms, to which the loss of three unfortunate men may be attributed. Tucker's confidence, however deceived, was founded on some experience, and Captain Kelly has some reason to believe that these natives (though certainly not to be depended upon) were fired in their revenge by the recollection of two or more of their people being shot by Europeans."

Thus ends the first article. In a subsequent number of the *Witness*, many years later, the story is given as follows, with a few additional points, and offering another motive for the killing of Tucker:—

"After Mr. Kelly's voyage in a boat round Tasmania, in the year 1815–16, he was given the command of the 'Sophia,' owned by Mr. Birch, of Hobart Town, and sent on a sealing cruise to New Zealand. One of his crew was a man named Tucker, who had in a previous voyage stolen from the natives at Riverton a preserved head, and only saved his life, as *utu*, or reprisal, from the natives by the vessel getting away before the theft was discovered. This was in 1811, and the baked head was the first offered for sale in Sydney. Whether Tucker thought that the theft had been forgotten or his offence condoned does not appear, as he had the hardihood to return and claim the friendship of the natives whose kindness and confidence he had outraged on a former occasion. At first the relations between the natives and the captain and the crew appeared of the cordial kind, and a Lascar, who was living among the tribe, volunteered to act as interpreter, as Kelly wanted some potatoes in barter. On making inquiry after a boat's crew that had been lost in the neighbourhood, it transpired that the man who had had charge of the boat had been killed and eaten, with all the crew. Unwarned by this event, Kelly put confidence enough in the natives to go among them unarmed, when a shout or a signal was given, and Kelly and two men who went with him—Dutton and

* I do not know any *large* blue berry of a poisonous nature in New Zealand.

Wallon—were also seized, but got away from the mob and into the boat, where they found the man Robinson, who had charge, reeling from a blow on the head. The whole party was evidently meant for slaughter and food; but Kelly fought his way out, being half-armed with a billhook, which served him in good stead. Mr. Calder says, 'In the desperate hand-to-hand encounter which took place Kelly lost three of his people, and with great difficulty regained the 'Sophia,' from the deck of which* he was doomed to see one of his men (one of whom was his brother-in-law Tucker) cut limb from limb and carried away by the savages.'"

In conclusion, I may say that, taking all the circumstances into consideration, I think the vessel must have anchored in the stream about opposite to the present Maori settlement; that the captain and crew went ashore the first day on the south side; the next day they rowed about two miles outside the Heads to the north, to Murderers' Beach, when the massacre took place, out of sight of the ship; and that the settlement of Corockar ("the beautiful City of Otago of six hundred houses") was about where the huge drift of sand is now, on the south side of the entrance.

## Art. XVII.—*On the Forests of New Zealand.*

By A. Hamilton.

[*Read before the Otago Institute, 14th May, 1895.*]

The islands of New Zealand have, from the time of the earliest voyagers, been noted for their magnificent and impressive forests. Seen, as the country was, mainly along the coast, and up the estuaries and sounds, the hills and valleys appeared clothed with an almost unbroken dark-green mantle. The climate, though varied, was everywhere favourable to a luxuriant Flora, and stored up in the shady depths of the forest were vast reserves of moisture, which encouraged the growth of all plant-life, and acted as a reservoir for all the streams and rivers.

* Here the writer is probably incorrect, and meant that the captain saw Tucker cut up from the boat in which he was escaping (as in the first account), not from the deck of the vessel. In the first place, the vessel was two miles off, and probably not in view, and, even if it were, it would be difficult to see a man cut up at a distance of two miles; secondly, the natives would hardly defer the operation till the captain regained the ship.

The gloom of an American pine-forest was not there, as most of the bush areas in New Zealand, at the lower levels, are of a more or less mixed nature, and not confined to any one species of tree. The forest glades were shaded and cool, but the undergrowth of shrubs was vigorous, and ferns of many kinds grew in countless numbers and in all positions, forming mats on the ground, climbing up the trunks of tree-ferns or trees, or perching themselves in the fork of some giant pine or broadleaf, shared their breezy post with, perhaps, an Astelia or some other plant, whose seed had by some chance lodged there, in a suitable place for its development. Life was rampant everywhere. The giant pine, which had struggled and grown skyward during the ages, and had at last died and fallen crashing to the ground, formed in its decay a nursery for the growth of its successors, and numbers of small and lowly forms of plant-life. We can scarcely picture to ourselves any commencement of this domination of the dry land by the vegetable creation, and, doubtless, the areas under bush varied considerably from time to time in accordance with the existing geological conditions; but probably for a long time before the advent of man to New Zealand the land area, as we now see it, was much the same in extent, and largely covered with bush. The advent of savage man would make very little difference in the scene. His tools were feeble, and his wants were few; the only factor of destruction that would make any material difference would be the starting of fires by artificial means, either intentionally or by accident. In this part of the country destructive fires could only occur in exceptional seasons; but some such cause must be put forward to account for the disappearance of the timber from a very large area of Southland and Otago. There is, I believe, a tradition of the whole country between Southland and Canterbury having been swept by "the fire of Tamatea."

This tradition of a great fire is, however, also found in the North Island, and is considered by experts to relate to an experience in some other country, and to refer to some great fire caused by a volcano. The introduction of agricultural operations has produced certain changes by diverting drainage-channels, draining swamps, and altering generally the original local conditions.

It would be an interesting study, and surely not difficult to accomplish with the co-operation and help of members of the Institute and their friends, to mark on a map the areas in Canterbury and Otago which even now show lingering traces of forest-growth in the shape of buried stumps and huge logs, the heart-wood—often charred—of great trees. In many parts of the North Island great quantities of sound timber is to be found buried, and was much sought after

by the Maoris for carvings and work requiring well-seasoned wood.

During the Maori occupation of New Zealand the natives found in the bush a large quantity of their food-supply, and possessed an accurate knowledge of the trees and shrubs growing in it.

Having thus very briefly noticed what may be called "the past" of the New Zealand bush, let us take a glance at the present position, and what may be the future of it. At the present time the supply of first-class timber easily accessible is by no means large, and, in view of the recent developments in the timber trade, in paving-blocks, and the official attempts to encourage the export trade, it is of special importance that some attention should be given to the subject of utilising the forests to the best advantage. The forestry question is one which has sprung into existence as a science within the last half-century, and has been made the subject of careful study by some of the Continental nations. In India the Government have carried out in a most successful manner the practical management of their extensive forests and plantations, and recently the subject has been forced upon the attention of the United States, and is receiving due attention.

The Governments of New Zealand have already done a little in the way of obtaining reports on the character and areas of their forests, and have very wisely reserved certain areas of bush as climatic reserves, and a department was organized for the conservation of forests, which after a short existence was abolished. The objects aimed at were excellent, and it will yet be found necessary to carry them out, but possibly on different lines.

According to official returns,* there yet remains of the heritage which the colonists have acquired, in the Auckland District, 5,220,000 acres. These forests are described as being full of valuable woods, including all that remains of the kauri, the pride of the New Zealand forests; and I am glad to notice that the report says *all* the bush is useful for building, fencing, or household purposes; and that upon the Crown lands there is still kauri standing valued at one million and a quarter. The report also remarks that the only really good Crown lands fit for settlement in the north are still covered with forest, and must be cleared and sown before any return can follow. I do not know these lands, but on general principles I hope that they may be preserved as forests, and land for *bona fide* settlement found elsewhere.

In Taranaki, the gross area of the district is 2,430,000

* New Zealand Year-book, 1894.

acres, and 1,850,000 acres are still bush, 170,000 acres of bush having been already cleared. A forest reserve of 72,000 acres, a circle with a six-mile radius from the top of Mount Egmont, has been made, and has, I find, a Forest Board of Conservators. Of land still available for settlement, 921,000 acres of forest-land remains to be dealt with. Fifty thousand acres may be suitable for agriculture, and 871,000 will be good pastoral land. From this the writer evidently looks forward to a time when the whole of this vast area of bush has been destroyed, and replaced by grass and crops.

In Hawke's Bay there are extensive climatic reserves in the mountain-ranges, and to the north are the primeval forests in which the Ureweras live, at the back of Waikaremoana. The forests known as the Seventy-mile Bush have already yielded an enormous quantity of sawn timber, and a very considerable area of excellent totara forest has been completely destroyed. From the look of the small patches which have here and there escaped destruction by axe or fire, it is more than probable that with proper management the mature timber might have been utilised and the immature trees brought into maturity; and it is a matter for serious inquiry whether the labour, time, and money spent in destroying the bush and putting the land into grass gives a better return than could be got from the valuable timber that might be produced from the land under practical scientific management, together with the utilisation of the by-products and the partial use for grazing purposes. The northern portion of the Seventy-mile Bush supplies not only the greatest quantity but the best quality of the valuable totara timber, and a properly managed area devoted to the growth of this tree would eventually be of great value and benefit to the State.

In the Wellington District, out of 6,000,000 acres, more than half are still under bush, and a large quantity of splendid timber is to be found within this area. Much of it will, however, be always inaccessible owing to the rugged nature of the country.

In the Marlborough District there was formerly about 400,000 acres of forest, but a very large quantity has been cut, and a considerable area cleared.

The forest-land of Nelson comprises about 3,250,000 acres.

The Province of Westland is almost entirely forest-clad from the snows of its mountain-ranges to the sea, and is estimated to contain 2,895,000 acres; and but little, comparatively speaking, has been done in the way of either utilising or destroying any of this important national asset. The heavy rainfall (120in.) on the coast decreases the risk from forest fires, which are assuming serious proportions in dry seasons in Wellington and Hawke's Bay.

Crossing the great range of the Southern Alps we come to a different climate and country, and in the eight or nine million acres in Canterbury the estimated area of forest-land is under half a million acres—an area chiefly made up by patches of bush at the heads of the rivers and on the mountain-slopes.

The treeless plains of Canterbury continue across the Waitaki, and the whole of Northern and Central Otago are practically treeless, and consequently dry—cold in winter and hot in summer. Of the 9,000,000 acres included in the Otago Province only a small portion is forest-land. The Catlin's and Tautuku forests contain a considerable amount of marketable timber, though in the former district the timber most easily accessible has been cut. To the westward there are several considerable patches about the lakes, and the southern and western regions of Southland have still a good deal of bush, but, including Stewart Island, there is only half a million acres out of about 7,000,000 comprised in the district.

The forests in the more immediate vicinity of the centres of civilisation have of necessity been cut out and worked to supply the requirements of trade; and in the goldfields district the scanty trees have been destroyed for mining purposes. To their legitimate use no objection can be taken, however one may regret the manner in which it has been done; but when the beautiful scenery of some of our lakes has been temporarily ruined, in part by fires, raised either intentionally or unintentionally, it is a different matter, and one which cannot be too widely discussed and deprecated. The instances which we have already had of the ravages fire may make in a few hours in a forest which has been the growth of centuries render it imperative that every care should be taken, under proper directions, for the conservation of the natural beauties in each and every place when they are not in the way of the advancement of the settlement of the country.

In this connection it is satisfactory to notice the plantation reserves made in various parts of Otago, and the apparent impetus given within the last few years to tree-planting by the institution of Arbor Day. That the interest of settlers can be aroused in tree-planting and improving bare and waste places is apparent. Observation also shows that, with the best intentions, ignorance of the kinds of trees most suitable for such planting is widespread; and to a certain extent this is not to be wondered at, as it is quite impossible to recommend a selection of any considerable number of trees that would certainly grow and prosper under unknown conditions of soil, aspect, or climate.

The neat gardens at our railway-stations, and the local

efforts of the Amenities Society, are having a decidedly good effect already on the environs of Dunedin, and thus indirectly on all those who may see, as we in Dunedin have seen, the waste places, if not "blossom as the rose," at least become places where the eye may refresh itself with the sight of well-grown and well-cared-for trees and flowering shrubs. Turning again to the forests of the country, and regarding them as the property of the nation, what do we find to be the state of affairs? The area of forest-covered land at the present time is, roughly speaking, twenty and a half millions of acres. The State forest reserves, including those made for climatic purposes, amount to 1,141,778 acres. The area of the North and South Islands, with Stewart Island, being about 66,341,000 acres, there is, therefore, nearly a third of New Zealand still bush, and reasonable provision seems to have been made by the State for the protection of river-sources, &c. Several Governments have also encouraged plantation of areas in treeless districts by either bonuses or grants of land. The Vogel Government in particular employed a well-qualified expert—Captain Campbell Walker, of the Indian Forestry Department—to report on the forests; and, although the examination was unavoidably a hurried one, and there was great difficulty in getting reliable statistics, the report presented was a valuable one. It points out that, though there was no immediate prospect of a dearth of timber or of injurious effects from clearing, it was imperative that State reserves should be made, not only for domestic reasons, but with a view of providing revenue for the initial expenses and maintenance of a scientific department of forestry, and for the replanting denuded hill-sides and plains destitute of timber. He also points out that no forests, however large, are inexhaustible unless worked under systematic principles which insure precautions being taken against waste in the procuring of the timber and proper methods followed for reproduction and protection against fire and damage from animals. Again, in the case of the so-called inexhaustible forest of the wet West Coast, a great proportion is situated in very inaccessible places, and is of little or no commercial value as timber; besides which, in the case of narrow valleys with steep, shingly sides, covered with but a thin coating of vegetable deposit, we cannot be too careful how the forest is removed, the result of any general or extensive clearing being that the little soil there is is soon washed away, leaving bare hill-sides of no value for any purpose, and resulting, by the rapid pouring-off of the rain-water, in most disastrous floods, followed by long and often equally disastrous droughts.

This is so well known and recognised on the Continent of Europe that what is known as "selection felling," by which

individual trees only are removed as they mature, is the system universally in force, and experience teaches us that any departure from it under such circumstances is very dangerous, and should be invariably avoided if possible. This must strike any one who has studied the subject; and no conclusion is more firmly impressed on my mind than that, whilst New Zealand has a splendid and most valuable property in her forests as they exist now (1877), she must be very careful in her management of them, and no longer proceed blindfold in their disposal and removal, otherwise she will not only lose them, without any adequate return or income to the public or colonial purse, but very much beside in the way of equable climate, and ample but not excessive supply of water, which years of labour and heavy expenditure will hardly replace.* In endeavouring to arrive at any understanding of the manner in which the forests, public and private, are dealt with in New Zealand, reference must be made to this report; and it is evident from the valuable summary given at page 45 by Mr. Thomas Kirk, F.L.S., that at that time there was nothing like a uniform system of controlling the use or the abuse of the national forests.

With regard to the future of our forests, there is one danger which becomes year by year more imminent, for as the settlement of the country progresses fires are started on every hand, either to burn the felled bush or scrub or for grass-burning. It is from uncontrolled fires that I apprehend most danger to the forests and greatest destruction to the scenery and natural features. In consequence of the fearful forest fires which ravaged five of the American States on the Canadian border last year, the National Government will probably be moved to override with a comprehensive Act the legislation of the various States, and make some general provision for taking precautions against such disasters; and any Bill for this purpose that bears the stamp of expert scientific knowledge will no doubt receive the support of the senators. This matter, and the prevention of "lumber-stealing," is attracting much attention in America just now, the American Association for the Advancement of Science and the Irrigation Congress having indorsed a plan proposed by one of the Harvard professors for the management of the forest reserves already made and to be made. It contemplates the transfer of all these reserves to the War Department, and their supervision or management by army officers, to be educated in the principles of scientific forestry at West Point Military Academy or elsewhere, the force of labourers to be employed to consist of a forest guard, locally enlisted. A number of

* Report of Captain Campbell Walker, C.-3, Parl. Rept., 1877.

letters from experts have already appeared on the subject in the American magazines, and all seem to recognise that a disciplined force judiciously handled could control many of the disastrous fires which occasionally ravage the country, although they do not agree on the details of administration. Matters have been dealt with in British India much more practically, and regulations against forest fires have been enacted for the last twenty years—at least, in all the provinces under our control, and also to a certain extent within the native States. As a result of these regulations, and the careful management of the Indian Forest Department, 23,144 square miles of State forest in India were protected from fire in 1891, at a cost of nine rupees per square mile, and this in addition to large areas of evergreen forest where no danger from fire exists. The chief of the American Bureau of Forestry has recently stated that the annual loss to the Government by thieves is from ten to fifteen million dollars, whilst that by fire is probably twice as much more. To protect the 20,000 square miles of Government forest land a paltry force of twenty to twenty-four watchmen is employed, and even these are not armed with sufficient authority. They are barely able to reclaim some hundred thousand dollars' worth of timber annually from depredation, which only suffices to pay the expenses of the maintenance of the service. Proper protection would require an outlay of two or three million dollars, and would preserve twenty to fifty million dollars' worth of property in each year.

It is not suggested that the above are parallel cases to ours in New Zealand, and fortunately the majority of our forests are green and not so highly inflammable as the vast pine-tracts of America; still, those who have paid any attention to the subject will recognise that, if in the neighbourhood of valuable or specially beautiful bush the local population were properly organized and instructed, much might be done to minimise the great damage which has from time to time been suffered, not only financially, but from the æsthetic point of view. It is much to be regretted that the New Zealand settler has been encouraged to do his best to destroy utterly every green thing upon his section, and that he looks forward with anxious fears and hopes to the burning of not only his timber and brushwood, but in many cases most of his mould or soil. No doubt the cleared bush-land will give him a chance of forming beautiful grassy paddocks, with a heavy sward of English grasses. It is true that New Zealand bush will not, as a rule, bear tampering with, and that trees or clumps, if left, will soon perish; but it would be well if those who hold bush-land which is to be felled would carefully examine it and see if there are not some naturally isolated portions which could

be spared—at any rate for the present. I even hope that before long, when bush-lands are put up for sale, in all large blocks such natural reserves will be described, and, if not reserved or protected, that the purchaser will have his attention drawn to the possibility of conserving that portion and the desirability of its being done.

It may, perhaps, be of some interest to the members if I give you some account of how some of the European nations manage their timber resources, and how far civic rights override private interests.

In Germany the schools of forestry are in the highest state of development, and expert knowledge is easily procurable, and is widely diffused through the Empire; and probably it is owing to this that the actual laws regarding the use of private forest property are less stringent than among other nations who have paid less attention to the subject. The various Governments own and manage in a conservative spirit about one-third of the forest area, and they also control the management of another sixth, which belongs to cities, villages, and public institutions, in so far as these committees are obliged to employ expert foresters, and must submit their working-plans to Government for approval, thus preventing improvident and wasteful administration. The principle on which the control is based is one which we recognise when we limit by law the indebtedness any community or town may incur. The other half of the privately-owned forests is managed mostly without interference by trained foresters, who receive their education in one of the eight higher and several lower schools of forestry which the various Governments have established.

In Bavaria, Baden, Würtemberg, and other principalities, clearing without the consent of the authorities and devastation of private forests are forbidden, and there are also some regulations regarding the maintenance of protective forests; but, altogether, the laws are not stringent.

In Prussia, which represents two-thirds of Germany, private forests are absolutely free from governmental interference. When, however, a neighbour fears that by the clearing of an adjoining forest his land may be injured he can call for a viewing jury, and possibly obtain an injunction against the clearing, if such anticipated damage is proved. The Government can also make application for such a process in cases where damage to the public can be proved from a wilful treatment of a private forest. The tendency of the Government has in practice been rather towards persuasive methods. Thus, in addition to buying up or acquiring by exchange and reforesting waste lands—some 300,000 acres have been so reforested during the past twenty-five years—the Government gives assistance to private owners

in reforesting their waste land. Popular opinion is now calling for a closer supervision and an extension of the control of the State over the use of private forest property.

The status of forest legislation is very different in Austria, where, with a larger proportion of mountainous territory, the results of the unrestricted exercise of the free-will of the private owners are more severely felt. The Mediterranean coast, which was ever well wooded and watered, rich and fruitful, and famous for its mild climate, has been changed into an arid and sterile plain, interspersed with stony and parched hillsides, the replanting of which was well-nigh made impossible by the opening of the country to the hot, dry winds. This and other experiences led in 1852 to the adoption of a forest law, by which strict supervision is provided for over the forests owned by communities and also over those owned by private individuals. Not only are the State forests (less than 30 per cent. of the forest area) rationally managed, and local administration supervised, but private owners (holding 32 per cent.) are prevented from devastating their forest property to the detriment of their neighbours. No clearing for agricultural purposes can be made without the consent of the district authorities, from which, however, there is an appeal to a civil judge as arbitrator. When dangers from land-slides, avalanches, or torrents are feared, and private owners cannot bear the expense of precautionary measures, the State may expropriate. Any cleared or cut forest must be replanted or resown within five years. On sandy soils and mountain-sides clearing is forbidden, and only cutting of the ripe timber is allowed. When damage is feared from the removal of a forest-belt which acted as a breakwind, the owner may not remove it until the neighbour has had time to secure his own protection. That neglect in taking care of forest fires subjects the offender not only to fine but to paying damages to the injured goes without saying. In addition, freedom from taxation for twenty-five years is granted for all new plantations, and premiums are paid under certain circumstances. The authorities aid in the fighting of fires as well as in destroying insect-pests. Finally, to insure a rational management of forests, the owners of large areas must employ competent foresters, whose qualifications must satisfy the authorities, opportunity for the education of such being given in seven higher-, three middle-, and four lower-class forestry schools.

In Hungary also, where liberty of private-property rights and strong objection to Government interference had been jealously upheld, a complete reaction set in some years ago, which led to the law of 1880, giving the State control of private property, as in Austria.

Italy furnishes perhaps the best object-lesson of the relation between forest-cover and water-flow. In 1888 it was generally recognised that steps must be taken to arrest the destruction of the forests on the hills, and by the laws then passed the Department of Agriculture, in conjunction with the forestal committee of the district, is to designate the territory which, for public reasons, must be reforested under Government control. Private owners may associate themselves for the purpose of reforestation of areas, and may then borrow money at a low rate of interest from the State Soil Credit Institution. The Forest Department contributes three-fifths of the cost on the condition that the reforestation is done according to the plans of, and within the time specified by, the Government. Where the owners do not consent or fail to do the work, the department has the right to expropriate and reforest alone—the owners having, however, the right to redeem within five years by paying expenses up to date. The department has also the right to restrict pasturage in alpine forests, paying, however, for damage sustained by the owner. Under the above regulations half a million acres have been replanted.

It was in 1888 also that Russia put an end to liberty to cut, burn, destroy, and devastate. The law as it now stands is administered, as far as protective forests go, by a forestry council, consisting of law officers, officers of the general administration, and the local forestry administrators. For private forests, not classed as protective, the right to clear is to be dependent on the consent of the council; while, too severe cutting, or the cutting of too large a proportion of timber without a view to reproduction, is forbidden. If any devastation takes place replanting becomes obligatory, and the Government forester may execute the planting at the expense of the delinquent owner. Assistance is given towards rational forest-management, and the Government sustains four higher, seven middle, and thirteen lower forestry schools.

In Switzerland sporadic enactments of individual cantons to check forest devastation are found as early as the thirteenth or fourteenth centuries, but it is only within the present century that the matter has been seriously taken in hand by the different cantons. In 1876 a Federal law was passed which gives the Federation control over the forests of the mountain région, embracing eight entire cantons and parts of seven others, or over a million acres of forest. The Federation itself does not own any forest-land, and the cantons hardly a hundred thousand acres—somewhat over 4 per cent. of the forest area, two-thirds of which is held in communal ownership and the rest by private owners. The law is quite remarkable as illus-

trating the rational principles upon which the little republic works, maintaining close relationship between the general and cantonal governments. The Federal authorities have supervision over all cantonal, communal, and private forests so far as they are "protective forests"; but the execution of the law rests with the cantonal authorities, under the inspection of Federal officers. "Protective forests" are those which, by reason of elevation and situation on steep mountain-sides, or on marshy soils on the banks of brooks or rivers, or where a deficiency of woodland exists, serve as a protection against injurious climatic influences, damages from winds, avalanches, land-slides, falls of rock, inundations, &c. The cutting in these forests is regulated so as to insure a conservative use and to prevent destruction. Where needful reforestation is mandatory, the Federal and cantonal governments share in the expense, or may expropriate, with payment of full indemnification to the owners. No diminution of the forest area within the established area of supervised forest is permissible, and replanting is prescribed where necessary; nor can township or corporation forests be sold without the consent of the cantonal authorities. The national government contributes from 30 to 70 per cent. of the cost for the establishment of new forests, and from 20 to 50 per cent. for planting in protective forests. Where special difficulties in reforestation are encountered, or where the planting is deemed of general utility, the cantonal government assumes the obligation of caring for and providing improvements in the plantings. The employment of educated foresters is obligatory, and, to render this possible, courses of lectures to the active foresters are maintained in the cantons. There is also an excellent forestry school at Zurich.

In France, before the Revolution, the Forest Code of 1669 enjoined private owners to manage their forests upon the principles on which the Government forests were managed, which was by no means a very rational management, according to modern ideas, yet was meant to be conservative and systematic. During the Revolution a law forbidding clearing for twenty-five years was enacted; and later laws, the most important of which are those of 1860, 1862, and 1882, establish the control of the State over all "protective forests," and make mandatory the reforestation of denuded mountains. Not only does the State manage its own forest property (one-ninth of the forest area) in approved manner, and supervise the management of forests belonging to communities and public institutions (double the area of the State forests) in a manner similar to the regulation of forests in Germany, but it extends its control over the large area of private forests by forbidding any clearing except with the consent of the forest administration.

The reforestation of denuded mountain-slopes is encouraged by the granting of financial aid or of plant material, in proportion to the general good resulting from the work. If it is found necessary to take land and plant it (in cases where the owners are unwilling or unable to do the work), the Government do the work and hold the land until the cost is repaid.

The Government, if desired, or where success depends on it, superintends the planting, and also regulates the use of these protective forests afterwards. The success of the Government in replanting the sandy wastes in the south of France is well known; and in a recent report of the British Consul at Bordeaux he refers to the forests, which cover about a third of the department, especially the Landes District, where the soil is wholly unfitted for ordinary cultivation. Here, he says, forests of pines (*P. maritima*) have in recent times been planted, and the wood and the resin obtained from them have now become an important, and in some instances the sole, source of revenue of the people of those districts. In the parts distant from towns and other inhabited places resin is chiefly produced, while in places nearer to Bordeaux or other shipping ports, where means of transportation exist, the production of pit-props, railway-sleepers, telegraph-poles, and wood for fuel form the chief business. A new oil, called pine-oil, is now being made from the refuse of resin after the latter has been employed in making turpentine. It is a good illuminant, cheaper than kerosene, and non-explosive. A large quantity of the young pines are used in making certain kinds of paper.

In order to gain the confidence and co-operation of the communities and proprietors in planting fresh areas, annual meetings were held in different parts of the country, in which the Government agents explained the advantages and methods of *reboisement* and discussed the local conditions and difficulties. These meetings proved a great success, and much advanced the cause of rational forestry. As a result of these meetings, and of the education resulting from them, it was found that in 1888 an area of about 365,000 acres had been reforested, of which 90,000 were private and 125,000 communal property, the rest belonging to the State.

The cost per acre for reforesting was somewhat less than £2, and the State has expended already about £2,000,000. It is estimated that 800,000 acres more are to be reforested, and an additional expenditure of seven millions and a half is necessary before the damage done to the agricultural lands of eighteen French departments by reckless forest-destruction will be repaired.*

* For the details concerning the European countries I am much indebted to an article by B. E. Fernow, in the *Century* Magazine, April, 1894.

In recent years the Government of India has paid much attention to the preservation of its valuable forests, and is now reaping the benefit in the large income derived from the sale of timber. The establishment of the Government department of forestry is of recent date, brought about by the destruction of the forests for fuel, for charcoal, and other wasteful courses. In 1844 and 1847 the subject was first taken up by the Governors of Bombay and Madras. In 1864 an Inspector-General of Forests was appointed, and in 1867 the regular training of forestry officers was commenced in the schools in France and Germany, where it is still continued.

At present discriminate timber-cutting is allowed, but the burning of hill-bush is stopped, the forest areas are surveyed and marked out, plantations laid out and maintained, and forestry-conservation otherwise carried on.

Forests are classified as "reserved" and "open." The former are the immediate property of the State, and are managed by the Forestry Department, their development being a source of revenue. Cattle are excluded from them, undergrowth destroyed, and the cutting of timber strictly regulated. The open forests are less strictly guarded, but certain kinds of timber-trees are protected. Large sums are spent annually in new plantations, and in planting young trees to replace those cut. In 1878 there were 12,000,000 acres of reserved forests; the revenue was £660,000, and the expenditure £400,000, showing a fair nett profit. Ten years later (1888) there were 43,520,000 acres of State-forest land, the nett revenue, after deducting all working-expenses, being £400,000. The forestry officials generally hold that the effect of forest-denudation on rainfall is doubtful, and much disputed. Contrary to what might have been expected, there is no evidence to show whether the actual rainfall has increased or decreased in consequence. They all agree, however, that forest-denudation has acted injuriously by letting flood-waters run off too rapidly, and that these waters are practically lost.

Three-quarters of a century ago, immense tracts of Southern India were overspread with jungle, and the slopes of the Ghauts were universally timber-clad. The most of the level woodland has since been cleared for cultivation, and the timber cut down for fuel. But another and scarcely less evil has resulted. Formerly the water was more or less protected from evaporation by the sheltering trees. Its flow on the surface was mechanically reduced by the jungle-grass and tree-trunks; it had time to sink into the earth, thereby insuring the permanence of the natural springs. Not till this was done did the residue find its way to the rivers, and then at a comparatively tardy pace. Now, however, as a

rule, the rivers are in violent flood for about as many days as they used to be for weeks in moderate flood.

Turning again to New Zealand, we find that the extensive burnings of the tussocks and small scrub has produced similar conditions in many of our rivers, the rainfall flowing almost immediately into the channels, and not being detained by coarse or dense vegetable growth. Fortunately, however, there are few places in this country where extensive replanting is required for protective purposes. But in this part of the South Island, the Otago and Canterbury Plains, much may be done by the planting of timber trees suited to the locality, the wood of which will be of service for manufactures or industries. The experience of the European countries and of the United States seems to show that a central administration is essential, administering a well-drawn scientific Forest Act, in conjunction with such local authorities as may be advisable, the chief aim being to indicate the proper methods of dealing with the timber now most easily accessible so as to prevent undue waste, and, wherever possible, to encourage the work of reproducing the forests; also to arrange for easy access to the best forests, and to provide for their safety from fire or unauthorised destruction. What is required may be shortly stated under the following heads:—

*Forest-management*, which would deal with all parts of forest science which influence the control and working regulations, including finance.

*Forest-utilisation*, which would deal with the technical qualities of timber, consumption of wood, the felling and shaping of trees, the disposal and transport of wood, the harvesting of by-products, such as resins and turpentines, &c.

*Forest-protection* against fires and man, against animals, insects, fungi, having regard also to climatic considerations.

Lastly, *sylviculture*, or the creation, regeneration, and recovery of woods adapted to the varying local circumstances. For this part of the country this branch of the subject has the greatest importance, and demands an exact knowledge of the principles of the science.

Forestry, besides these branches of study, is largely based upon empirical knowledge, and to insure the best results forest science or theory must go hand-in-hand with practical forestry, neither the one nor the other by itself making a forest expert. The importance and absolute necessity of this is shown by the courses followed at the various forestry schools in Europe, at all of which practical instruction is strongly insisted on.

There is one other cognate subject that I should like to say a few words on, and that is irrigation. If fruit-growing and vine-culture is to be such an important factor with those

who live "over the garden-wall" in Central Otago it will be necessary in many places to provide for irrigation. The annual reports of the United States Irrigation Survey, from the commencement in 1888, are to be seen in our library, and if those members who are interested in the subject will consult these volumes I am able to promise them an interesting and valuable series of memoirs on the progress of the investigation of the hydrographical and topographical problems of irrigation. Amongst other things, attention is called to the more modern methods of gauging river-flows, and the great discrepancies sometimes found to exist in this respect between theory and actual results.

The question also of the water-supplies for our towns is one of great importance, but has scarcely received the attention it is entitled to. I trust that the local authorities will take care that the catchment areas of our town reservoirs are kept well covered with either bush or native scrub; otherwise, as I have pointed out, the rainfall over the whole area is thrown off more quickly than it should be, and the town suffers either from a flood or a water-famine. None of the catchment area should be used for grazing either sheep or cattle. The alpine and subalpine forests are, of course, of great importance in regulating the supply of water available for gold-mining operations, and should be strictly conserved and increased where possible.

In thus glancing at some of the points connected with the forest question in New Zealand, and at the manner in which other countries have been compelled to grapple with the question, I trust that I have not been too diffuse for the short time at our disposal; but my object will have been gained if our members, and members living in Central Otago in particular, will endeavour to gather information bearing on the questions and send it to the society, and so long as I continue in office I shall have much pleasure in doing my best to collect and arrange such facts; and I trust that in the not-very-distant future some member will be found who will take the matter in hand, and upon those data write a paper showing what is required to be done in definite districts, and how best to do it. It is only by recording and studying past successes and failures that progress is to be made; and a record of the experiments made by the various County Councils, Road Boards, and private individuals would have a permanent value; and it would be an interesting work, involving, however, some labour and time, to collect the information regarding the kinds of trees that have been planted, and those most successful. We must all hope that the days when nothing but *Pinus insignis* and *Cupressus macrocarpa* were planted are passed away.

In the matter of the forests at large, I have already said that I think there is little fear of destruction by legitimate use, but ravages from fire, especially in alpine districts, are to be dreaded, and must be guarded against. I would urge members to assist, when the time comes, in any way that they can, the organization of a scientific Government control of all the mighty forests of this land of ours. If the services of properly-trained men were obtained, and the administration of the State forests well organized, they might, I am sure, be made within a very short time to return a substantial nett income, more especially as the recent developments in the timber trade in England seem to promise a new opening for New Zealand woods, and, unless the opportunity is lost by either carelessness or dishonest shipping, important results may follow. It should be remembered that England imports twenty million pounds' worth of timber annually.

## ART. XVIII.—*On the Rise and Progress of our Knowledge of the Oceanic Areas.*

By A. HAMILTON.

[*Being the Presidential Address delivered before the Members of the Otago Institute, 12th November, 1895.*]

INHABITING as we do one of the outposts of civilisation, an island remote from continental areas, situate in a commanding position in the great Southern Ocean, our thoughts and actions are largely influenced by our essentially marine environment, and, apart from the commercial advantages that an extensive coast-line gives us, most of us have an interest in the exploration and unravelling of the mysteries of the sea. Thanks to the wonderful development of all branches of science during the latter half of the present century, we may now hope for things which only in the days of our fathers would have been deemed impossible. It may perhaps interest you if this evening I briefly trace some of the leading features in the history of geographical exploration by the voyagers of the bygone ages, and finally note some of the results of the most memorable voyage of modern times—a voyage which has done so much to establish the foundations of the science of oceanography—the voyage of H.M.S. "Challenger."

Commercial reasons have in nearly all cases been the cause which led the hardy sailor to adventure his life in his frail bark amid the dangers of unknown coasts, and in the

dawn of history we find several of the more civilised nations gradually extending their borders, and, though records of their geographical knowledge do not exist, we may feel assured that traditional information was being accumulated concerning local areas.

Geographical knowledge among primitive races is always circumscribed, and essentially local, and we have no glimpse of any considerable maritime discoveries of any extended area, or of any journeys of exploration, until we come to the time when the Phœnicians spread along the shores of the Mediterranean. Before this time they are said by Pliny to have voyaged from island to island in their original abodes within the Persian Gulf by means of rafts.*

Tradition, as well as the earliest records, represent this people as clever navigators long before the oldest Greek or Hebrew records. They are generally supposed to have fully explored the Erythræan Sea before they ventured on the waters of the Mediterranean. The 27th chapter of Ezekiel shows how the trade of the Levant was in their hands; and then, having traversed the Mediterranean and made themselves masters of the commerce of the day, they passed out into the waters of the Great Sea through the Pillars of Hercules, and founded Tartessus as a base for future voyages.

At a later date they went further afield; but a writer about twenty years ago tried to prove in an elaborate paper that the Phœnicians had reached Central America by way of the north of Australia and Easter Island,† and many similar attempts have been made to extend their voyages to parts of the American Continent. They sailed boldly to the Canaries, and a passage in Theophrastus‡ seems to indicate that the curious patches of floating seaweed known as the Sargasso Sea were known to the ancients. The Phœnicians steered during the night by a star in the Little Bear, which was called by the Greeks in after-times the Phœnician star. The course steered was, however, probably never very far from land. When the Greeks in their turn became a maritime power they directed their course by a position of the constellation of the Great Bear, until, in the time of Thales, they adopted the Little Bear as their guide.

The knowledge of places, currents, dangers, winds, and other cosmographical details must have been handed down by tradition from one generation of sailors to another, and the knowledge received by the Greeks when the Greek civilisation

* Pliny, Hist. Nat., vii., 56.

† Gaffarel, "Compte Rendu du 1er Congrès des Americanistes," Nancy, 1875.

‡ Theop., Hist. Plant., iv., 6, 7.

developed must have included many observations and deductions based upon experience of solid value and importance. Yet the brilliant intellects of the Greek philosophers did not construct any very creditable theoretical conception of the scientific problems of the ocean. Together with the facts, no doubt, a number of "travellers' tales" and myths had established themselves; but, as Humboldt says, "Popular myths mixed with history and geography do not belong altogether to the ideal world. If vagueness be one of their characteristics, if the symbols which cover the reality be wrapped in a veil more or less thick, they show, nevertheless, the dawn of cosmography. The statements of primitive history and geography are not entirely ingenious fictions; the opinions which have been formed about the actual world are reflected in them."

Putting aside, as poetic accretions round the nature-myth of the history of the Golden Fleece, the classic accounts of the voyage of the Argonauts, we come to the poems of the Trojan cycle, and in the Homeric works we find the conceptions of the Greeks at that time as to the Cosmos. He describes the form of the earth as being like the shield of Achilles, with the river Oceanus for its rim.* Mr. Gladstone considers the shape of the shield to have been an oval or a parallelogram. The conception of a great circumfluent river, he thinks, was probably founded on a combination of a double set of reports: the one of great currents setting into the Thalassa or Mediterranean Sea, and seeming to feed it, such as those of Yenikale, the Bosphorus, Gibraltar; the other of outer waters, such as the Caspian, the Persian Gulf, and probably the Red Sea. As the external ocean-river served as the support to the celestial vault, we must conclude that these conceptions of the world were derived from Oriental sources. These ideas of an internal sea, with archipelagoes and a surrounding ocean-river, were perpetuated among the people down to the time of Hecatœus. It is not long, however, before we hear of lands beyond the outer ocean, and in Hesiod we may probably see the first germ of the Atlantis myth, now to be rediscussed by the publication of Plongeon's work in Central America.

With the rise of the Grecian power we find mercantile relations opened up with Egypt, the "China" of the civilised world at that period; and about 630 B.C.,† Herodotus tells us, the western portion of the Mediterranean, with the great Tyrian port of Tartessus, in the south of Spain, became known to the Greeks. The story of the founding of Massilia not only shows the noble sacrifices made by the Phoceans, who abandoned their city rather than submit to the conqueror's yoke, but shows that the voyage of nearly the whole length

* Il., xix., 374. † Herod., iv., 152.

of the Mediterranean was not dreaded, and that their geographical knowledge of the western end of the sea was probably fairly complete. That there were local difficulties and dangers which rumour and distance unduly magnified was probably expressed by the popular saying in Pindar,* "Neither wise man nor fool gets beyond the Pillars of Hercules."

It is not necessary to go into the curious fancies of the Ionian school of philosophers concerning the form of the earth. Pythagoras and his followers seem to have been acquainted with the idea of the spherical form of the earth, and it is believed that they adopted this view from the intercourse which enabled them to learn the astronomical information possessed by the Chaldeans and Egyptians.

Scientific inquiry began to emerge from the mists of philosophical speculation, and about four hundred and fifty years before the present era we find a more scientific spirit animating the literary men of the day. At this period appears Herodotus, of Halicarnassus, a great name among the writers of antiquity, who, besides his more common titles of the father of history—and lies—may be regarded as the founder of the science of physical geography. Here in his writings we get the *ὀργυιά*, the sailor's measure, the fathom, as the measure of both length and depth. In his writings the circumfluent ocean disappears, and he says, "I cannot help laughing a little at those who undertake to describe the contours of the lands without any facts to guide them; for example, who represent the ocean as embracing the entire world in its course—who make it round, as if drawn with a pair of compasses."† In both his historical and geographical work he seems to have preferred drawing from the living fount of oral tradition, but without perceiving the necessary shortcomings of such a record. In the matter of his credibility, it is necessary to distinguish between the trustworthiness of the historian himself and the trustworthiness of his authorities. As to the former, there is no occasion for doubting his personal good faith, or for disbelieving his assertion that he reproduced faithfully all that he heard. He exercises no scientific criticism of his authorities, nor does he allow for the weakness of oral tradition. But, while we may believe that Herodotus repeated what he had heard, it is impossible to have the same confidence in his authorities. Modern research has shown that he has been led into many mistakes by ignorant or malicious informants, and in his historical writings a distinctly Periclean bias is visible. Further afield were the voyages of Scylax, of Caryanda, down the Indus and into the Persian Gulf; and the expedition sent

* Olymp., iii., 80. † Herod., iv., 36.

by the Phocean colonists of Massilia to the North Sea, under Pytheas, the illustrious astronomer, who at that distant period had determined the latitude of Massilia with such exactitude that twenty centuries after Gassendi found it correct to within a few seconds. On this adventurous voyage Pytheas coasted Britain and crossed to the German coast, the "amber coasts" of the Baltic. It has been claimed that Pytheas attributed the tidal phenomena he met with to the influence of the moon, thus anticipating Newton by two thousand years.

It is probable that the Carthaginian explorer Himilco had visited or tried to visit the "tin country," and had passed through the straits northward for the purpose; but there is every reason to believe that any information gained by this expedition was jealously guarded* as long as possible, and that Pytheas had not their experience to assist him. In another direction Nearchus was making a famous voyage of discovery under the auspices of Alexander.

The philosophers of the school of Aristotle came to the conclusion that the earth was a spheroidal body occupying the centre of the universe, round which the other celestial bodies revolve. They were no doubt influenced by the results of the voyages of Euthymenes and Pytheas. They established its spherical form by the fact that all things gravitated towards the centre, and by reference to the shadow of the earth during eclipses.

The habitable world was confined to the temperate zone: all beyond the tropic to the south was uninhabitable from heat, while the land below the Great Bear was uninhabitable from cold. They admitted a temperate zone in the Southern Hemisphere, but do not state if it is inhabited.

Humboldt believed that the following passage must have had much influence in leading up to the discoveries of Columbus: "It appears," says Aristotle, "those are not so very far wrong who suppose the region about the Pillars of Hercules and that about India to be contiguous, and that there is but one sea (in the part opposite to the inhabited world); and they point by way of proof to the elephants, these animals being found in both regions, though at the extremes of the earth, this fact showing that the extremes are really near each other.†

Aristotle's own researches in the fauna of the ocean were of scientific value, as he named and described more or less minutely 116 kinds of fishes, about twenty-four Crustaceans and worms, about forty Mollusca and Radiates, making a total of 180 species, inhabiting the Ægean Sea. His immortal

* Clements Markham, R. Geo. Journal, 1893, vol. i., No. 6.
† Arist., De Coel., ii., 15.

memory is recalled to the zoological student in the masticatory apparatus of Echinus, known as Aristotle's lantern. Such was the authority of the Aristotelean views that they were held and reproduced by the Romans down to the close of the Middle Ages.

All maps or charts previous to Aristotle's time were merely pictorial sketches devoid of scale or proportion; but a pupil of Aristotle's—Dicœarchus—divided the representation of the known world by a longitudinal line in the sense of our equator, along which stadia were marked. By this means it was possible to express relative distances more precisely than formerly. This departure was followed up by Eratosthenes, of Cyrene, director of the library of the museum at Alexandria, who, encouraged by the patronage of the Ptolemies, arranged the geographical facts collected by the generals of Alexander, using the prime longitude of Dicœarchus, which passed through Rhodes. To this he added three others, passing respectively through Alexandria, Syene, and Meroe. He also traced at right angles to these a meridian line passing through Rhodes and Alexandria southwards to Syene *via* Meroe. Eratosthenes reformed the principles of geography, and gave it a more systematic form. He adopted the view of Aristotle and Euclid regarding the figure and position of the earth, looking upon it as a sphere placed in the centre of the universe, around which the celestial bodies moved every twenty-four hours, the sun and moon having independent motions of their own. For all practical purposes, his views differed only from those of modern geographers in having a geocentric instead of an heliocentric standpoint.

When the Romans had extended their dominions to Egypt they were able to acquire the geographical knowledge possessed by the school of Alexandria; but the genius of the conquering people was not directed towards scientific research, nor did they encourage navigation and commerce with the same ardour as their predecessors. The science of oceanography was not advanced among them as among the Greeks by the speculations of philosophers, or by the study of natural phenomena for their own sakes. It was only the luxury of imperial Rome, which gave rise to the demand for the varied products of all the countries of the known world, that led to active trade by land and sea. It seems natural to expect that the Romans, who carried their victorious armies throughout nearly all the world known to the ancients, should have left some important documents relating to the physical aspects of nature in the regions over which they extended their conquests. Although the Roman rule extended over a great extent of coast bordering on the Atlantic, they never organized any voyages of discovery into the outer sea, after the manner

of the Carthaginians and Greeks. They were essentially a warlike and practical people, with politicians, jurists, encyclopædists, and historians, but few philosophers who occupied themselves with the operations of nature.

Horace's system of winds, several passages of Virgil on meteorology, the statements concerning geological phenomena in Ovid, and notices of diluvial action on the surface of the globe in Vitruvius, all show a spirit of observation and inquiry; but, generally speaking, if we deduct what the Romans had received from the Greeks, there is little relating to oceanography that can be regarded as original among the writings of Latin authors. The military operations each occasioned a new survey and a new itinerary, though it was not till the reign of Caracalla that these itineraries were elaborated into accurate topographical documents.

As Vivien de St. Martin remarks, never was there such an opportunity for a great work on descriptive geography as during the reign of Augustus. The Roman rule then, spread as it was over more than half of the then known world, and attached to the remainder by political and commercial relations, created most propitious conditions for an undertaking of this kind by furnishing to the geographer a ready means of investigation. A man appeared to carry out the work for which the time was ripe, but the man was a Greek—Strabo, of Amaseia—who, in his seventeen books, has given us the most important geographical work of antiquity.

In the first century of our era was written the earliest work or treatise devoted exclusively to geography. It was written by Pomponius Mela,* a native of Spain. In this work we find the first notice of the opinion, so prevalent in aftertimes, as to an impassable zone intervening between our world and the *alter orbis* of the Antichthones in the temperate zone of the Southern Hemisphere. Passing on to the last great geographer of antiquity—Ptolemy—we find him devoting two of his numerous works to geography, and improving the *ars delineandi* and the *tabulas geographicis*; and he is the first to use the words "latitude" and "longitude" as purely technical terms. From this point the progress of geographical knowledge is carried on on two separate lines. The great outburst of Mohammedan conquest was followed by an Arabian civilisation, which had its centres at Baghdad and Cordova. The Arabs brought astronomy and mathematics to bear on its problems, and established observatories. They measured an arc of a great circle of the earth; they studied Ptolemy; they applied themselves to define with accuracy the discoveries of travellers; and thus geography became in their hands a

* De Situ Orbis.

living science. Abulfeda quotes no less than sixty geographical authors, many of whom lived in the thirteenth century.

In European countries the knowledge of geographical facts was limited to a few who were held fast in the chains of theology; and for centuries after the fall of Constantinople the darkness of the "dark ages" engendered strange and erroneous conceptions, which were only dissipated when, with the invention of printing, science once more lifted her head in Europe. The early Fathers of the Church—the autocrats of learning in those days—imagined that they had detected certain discrepancies between the discoveries of science and the words of holy writ. The particular point on which their suspicion fastened was the existence of the Antipodes. It was assumed that no communication was possible, or ever had been possible, between the Northern Hemisphere and any southern part of the globe. Even if other continents existed, they were supposed to be cut off from the European or Asian lands by an ocean lying under the tropical zone, of insupportable heat, and therefore impassable. On this assumption it was impossible that a population could have been derived from the stock of Adam, and consequently the whole theory of its existence was opposed to the language of holy writ, which throughout assumes that God hath made of one blood all nations of men for to dwell on all the face of the earth (Acts, xvii., 26).

Lactantius, in the fourth century, was so carried away by his zeal for what he believed to be the truth that he impugned the theory of the sphericity of the earth, and denied it as a physical impossibility.*

St. Augustine, while equally determined in his rejection of the Antipodes, is more cautious in the statement of his reasons. He argues that, even if the world is spherical, it does not follow that there should be land on the opposite side of it; and, even if there be land, it does not follow that it should be inhabited—nay, inasmuch as none could cross from this side to that, it must needs be uninhabited.† Geography was henceforth forced into a mould of a pseudo-orthodoxy, and both map-makers and writers were discouraged and fell into a narrow groove until they were forced out of it by the glorious discoveries of the fifteenth and sixteenth centuries. The tenacity with which the Patristic doctrines were maintained was exhibited in the treatment which Columbus received. His proposal to circumnavigate the world was referred to a council of divines in Salamanca, who pronounced it to be not only chimerical,

* Instit., iii., 24. † De Civ. Dei., xvi., 9.

but even profane, as being contrary to Scripture and the opinions of the Fathers. Yet at that time a breach had already been made in the mediæval theory by the progress of maritime discovery: navigators had penetrated into the torrid zone, and had reported it to be not impassable; and thus the very groundwork of the difficulty which the Fathers had experienced had been removed. It may be a matter of surprise that the Arabian system should have coexisted side by side with the Latin and yet have exercised so little influence over it. The inhabitants of Western Europe came into contact with the Arabs in Spain, in the Holy Land during the period of the crusades, and more particularly in Sicily, where one of the most illustrious of their geographers, Edrisi, lived and worked, under the patronage of Roger, Count of Sicily, in the middle of the twelfth century. We do, indeed, meet with occasional notices which show that the Arab system was not wholly unknown. Roger Bacon, in his Opus Majus,* completed in 1267, speaks of Arym, the most important point in the construction of an Arab map, and he shows himself acquainted with its position on the earth's surface, and its use in the study of geography. He was also familiar with the lines of latitude and longitude, and particularly notes that the Latins had not yet adopted the system.

The geographical work of Ptolemy had not yet been rendered accessible to the general body of students by being translated into Latin. The European system was incompatible with scientific principles: nothing less than a revolution was required, and that revolution was effected, partly by the revival of the study of Ptolemy—whose geographical writings were translated into Latin in 1405—and partly by the progress of maritime discovery. It may be of interest to take a passing glance at a peculiar feature of mediæval cartography, in which Jerusalem is represented as occupying the central part of the habitable world. Whether the tenet was originally based on the language of Scripture, or whether the language of Scripture was applied in confirmation of a preconceived opinion, I know not. At all events, it is not the only instance in which men have conferred honour on their holy places by regarding them as occupying the central boss or umbilic of the habitable world. It was thus that the Greeks regarded their Delphi—*ὀμφαλὸς χθονός*—† the Hindoos their Merou, and the Persians their Kangdiz. It was not unnatural, therefore, that the Jews, and still more the Christians, should attribute the same property to Jerusalem, which

* Jebbs, edition Venice, 1750, p. 184.

† Pind., Pyth., vi., 3; *cf.* Soph., Œd. Tyr., 480; and Æsch., Choeph., 1034.

for centuries had been the focus of their aspirations. their anxieties, and their most earnest hopes and devoted exertions.

Scripture seemed to sanction this feeling. We find the following passages quoted for the purpose: "This is Jerusalem; I have set it in the midst of the nations round about her" (Ezek. v., 5). The 12th verse of the 74th Psalm in the Vulgate runs thus: "*Operatus est salutem in medio terræ*"; and again, in the 12th verse of the 38th chapter of Ezekiel, the Vulgate has "*umbilicus terrae*" for the Hebrew word "*tabur*" —the *midst* of the land.

A fourteenth-century writer describes Jerusalem as "*punctus circumferentiæ*," and exaggerates the historical claims to centrality by representing Judea as having been the seat of each branch of the human race, and the favoured scene of God's manifestation in the works of creation and redemption in the past, and of final judgment in the future. Mediæval cartographers gave effect to these views by placing Jerusalem as nearly as possible in the centre of the map, and this remained the custom till the middle of the fifteenth century. Assuming that Jerusalem occupied the central portion of the habitable world, and taking into consideration its position on the verge of Asia and in the line of the Mediterranean, it follows that Asia held one-half of the world, and Europe and Africa, being divided by the Mediterranean, must almost equally divide the remaining half; and accordingly, in the Alexandrian romance popular in Europe in about the thirteenth century, we find—

> At Asyghe al so muchul is
> So Europe and Affryh I wis.*

Also in the Cursor Mundi—

> For Asie is withouten hope
> As myche as Aufrik and Europe.†

The world was thus divided symmetrically into three parts, and is so represented in many of the small maps in the illuminated manuscripts of the period. The preponderating size of Asia was attributed to its being the inheritance of Shem, the first-born.‡ Although many geographers wished to consider Europe and Africa as one, thus making two halves only, the above-mentioned writer brings Scripture to bear on the point, and settles it in favour of the three divisions, on the ground that Ham and Japhet had their separate domains.

The habitable world was limited within a circle drawn from Jerusalem as a centre, and with a radius equalling the distance thence to the Strait of Gibraltar. Here was—

* Lines 55 and 56, Weber's Metrical Romances, vol. i.
† Cursor Mundi, l. 2097, Ms. R., 3, 8, Trin. Coll., Camb.
‡ Gervaise of Tilbury, Ot. Imp., ii., 2.

> The strait pass where Hercules ordain'd
> The boundaries not to be overstepped by man ;*

beyond which lay the "deep illimitable main," "the unpeopled world," of which the learned as yet knew nothing. Eastward the limit was fixed at the mouth of the Ganges. In this direction, therefore, mediæval geography, as it stood towards the close of the thirteenth century, had not only not advanced beyond the point at which Ptolemy left it, but had actually receded.

Although the usual form of the habitable world as depicted in the Middle Ages was circular, a quadrangular shape was sometimes adopted, based upon too literal an acceptation of the passage of the Scripture which speaks of the "four corners of the earth." There is yet another form in which a map was constructed, and which was perhaps more correct. On the Matthew Paris maps we are told that the world in its truest form resembles an extended military cloak (*chlamys extensa*). The *chlamys* consisted of a central square with wings added to it, wider at the bottom than at the top, the whole shape being a greatly truncated triangle. This idea was probably derived from Macrobius,† who in his turn borrowed it from Strabo (ii., p. 113).

Another point of interest is the orientation of the maps. Our predecessors, with few exceptions, placed the east in that position at the top of the map. Biblical considerations again decided this. The primeval abode of man was in the east, the terrestrial Paradise still remained there. On this subject of the location of the terrestrial Paradise there is a large mass of mediæval literature; but in the whole of it there is no doubt of its being an existing contemporaneous fact. Mandeville (cap. xxx.) says that he had not visited it himself on account of his unworthiness, but he describes it at length on the information of trustworthy persons. The four rivers of Paradise were usually identified with the Euphrates, Nile, Ganges, and Tigris, and the difficulty as to the widely remote sources of these rivers was solved by assuming that the rivers on leaving Paradise were submerged, and reappeared at these points.

The traces of this belief are to be seen even in the person of Columbus, for we learn in Irving's "Life of Columbus," book iv., chapter 4, that when the great navigator encountered the flood of the River Orinoco, in the Gulf of Paria, he thought it could be none other than the fount of Paradise.

Of the renaissance of enterprise and the desire for know-

* Dante, "Inferno," xxvi.

† De Somn. Scip., ii., 9, where Macrobius is commenting on Cicero's description, "*Angusta verticibus, lateribus latior*" (De Republica, vi., 20).

ledge in the fifteenth and sixteenth centuries, and of the part which science took in giving confidence to the sailor to stretch out to seek for lands afar, I may not at this time say much. As an illustration, however, of what were considered difficulties, it may be noted that all the expeditions sent out at various times from Portugal to round Cape Bojador, up till the year 1433, returned unsuccessful because of a reef which extended six miles seaward and barred the passage. With the discoveries of Columbus the whole fabric of geographical conceptions was shattered, and amid the growing light of scientific knowledge in Europe the fragments were reconstructed into a more adequate representation of the true forms of the continents and oceans. To us under the Southern Cross the 25th of September, 1573, is a day of note, for on that day the fearless Spaniard, Vasco Nunez de Balbao, beheld from the summit of the Sierra Quarequa a boundless ocean extending towards the setting sun—an ocean first ploughed by the keels of the ships of Magellan many years after, and subsequently named by Pigafetta "the Pacific." "For three months and twenty days we sailed," he says, "about four thousand leagues on that sea, which we call the Pacific, because during all the time of our navigation we did not experience a single storm.

The voyage of Magellan, from a geographical point of view, was the greatest event in the most remarkable period of the world's history, and far surpassed all others in its effect on oceanographical conceptions.

The memorable discoveries in the thirty years from 1492 to 1522 doubled at a single bound the knowledge of the surface of the earth, and added a hemisphere to the chart of the world. The fiery zone of the ancients had been crossed, a death-blow was dealt to Ptolemy's view that the Indian Ocean was an enclosed sea; the southern temperate zone of Aristotle and Mela had been reached. The sphericity of the earth and the existence of the Antipodes were no longer theories, but demonstrated facts. The impression produced by these great events can be traced in men's minds in all the great intellectual and moral changes which characterised the transitional period known as the Renaissance, and relit the torch of learning in Europe.

The geographical work of the sixteenth century was continued, but with less ardour, during the seventeenth century. The Dutch made discoveries in the "Great Ocean" of the western half of Australia. Tasman, in 1642, showed that Australia and Tasmania were surrounded by the ocean to the south; but the west coast of New Zealand, which he visited, was believed to be a part of the great southern continent.

The desire for more detailed geographical knowledge seems

to have slumbered again till the latter half of the eighteenth century, when the first of the memorable scientific voyages was initiated in the time of James Cook.

We must, however, not forget the expedition of Edward Halley, in 1699, to improve our knowledge concerning longitude and the variation of the compass: this was a purely scientific voyage. Of the geographical discoveries made since that time in these seas we have been favoured with several papers by Dr. Hocken, and it will therefore be permissible for me to pass on to the Victorian era, and the rapid increase in the scientific knowledge of the bed of the great ocean—a branch of oceanography but newly born. It may here be not out of place to remind you that the very bulk of the ocean as compared with the visible land gives it an importance which is possessed by no other feature on the surface of our planet.

Dr. John Murray has lately, after a laborious calculation from the most recent data, shown that the cubical contents of the ocean is probably about fourteen times that of the dry land. This statement appeals strongly to the imagination, and forms perhaps the most powerful argument in favour of the view—steadily gaining ground—that the great oceans have, in the main, existed in their present form since the continents settled down into their present form. When it is considered that the whole of the dry land would only fill up one-third of the Atlantic Ocean, the enormous disproportion of the two great divisions of sea and land become very apparent. The deepest parts of the ocean at present known are in all cases near land: at 110 miles outside the Kurile Islands the deepest sounding has been made, of 27,930ft.* The sea with the greatest mean depth appears to be our vast Pacific, which covers 67 millions of the 188 millions of square miles comprising the earth's surface. Of the 188 millions, 137 millions are sea, so that the Pacific comprises just one-half of the water of the globe, and more than one-third of its whole area. We cannot regard the soundings which have been taken by the various scientific expeditions, and which are still being taken as opportunities offer, as anything but the units of what is required. In the Central Pacific there is an area of 10¼ million square miles in which there are only seven soundings; while in a long strip crossing the whole North Pacific, which has an area of nearly 3 million square miles, there is no sounding at all. The immensity of the mass of waters in the Pacific, both in bulk and area, is difficult to realise, but it may assist us when we learn that the whole of

* On the 14th December, 1895, H.M.S. "Penguin" reports a sounding of 29,400ft., at which depth the sounding-wire snapped.

the land of the globe above the water-level, if shovelled into the Pacific, would only fill one-seventh of it. English science has recognised that of all the worlds she has to conquer the secrets of the ocean are of great importance to her welfare, not only for the safety of her navy and mercantile marine, but for the future extension of the magic girdle of modern times which has embodied in itself the shoes of swiftness and the cap of invisibility of the fairy tale, and which has practically annihilated time and distance in commercial transactions.

From almost every branch of physical science come questions which can only be solved by researches into the conditions which obtain in the ocean.

If the charts of the present day be compared with those in existence before Cook's time, the perfection now attained will be easily noted. This important branch of oceanography has been very greatly developed through the extension of geographical and geodetical knowledge under the impulse of commerce, colonisation, and interoceanic relations. Nearly all the regions of the ocean are accurately represented in our charts, even the polar regions so far as explored. The bathymetrical charts of Maury and Delesse and the wind and current charts of the Hydrographic Office all show great advances in those branches of knowledge. The latest cartographical elements introduced into our charts are those relating to the depth and nature of the bottom, which were specially investigated during the voyage of the "Challenger." The study of deep-sea deposits has been brought about by the requirements of navigation and the more modern applications of electricity, and now constitutes an important branch of oceanography.

The very important scientific voyage of the "Challenger" took place in the years 1872–76; and the scheme proposed "for the investigation of the biological, chemical, and physical conditions of the great oceans of the world" was successfully carried out. As soon as possible, the collections made and the facts observed were placed in the hands of the most eminent men in each department of science; and after more than twenty years of labour the final volumes have been issued. The unanimous testimony of the scientific world to-day is that the work taken in hand has been well and truly done. Never, says the leading zoologist in England, never did an expedition cost so little and produce such momentous results for human knowledge. The expenditure on the preparation and publication of the reports has been relatively greater, but the authorities of the Treasury may rest assured that the whole of the scientific world sets the very highest value on these volumes; and that, had it suited the dignity of an Imperial Government to treat the work on a commercial basis, instead

of liberally presenting copies of it to scientific institutions throughout the world, the publications could have been made to pay their own expenses by sales. Practically, the whole of the work of arranging for the proper description of the great mass of zoological material brought home has fallen to Mr., now Dr., John Murray, and he has brought to a successful conclusion the issue of the fifty quarto volumes in which specialists in all parts of the world have described the treasures brought home. In zoology particularly the researches of the "Challenger" have enabled a new division to be made of the fauna of the ocean into three groups: a group that drifts, a group that swims, and a group that is anchored.

The first group, or the Plankton, embraces all those pelagic forms that float about at the mercy of the winds and tidal currents, drifting with the tide on the "shifting currents of the restless main."

The second group are the Nekton, also pelagic in their habits, but able to swim against the currents or migrate from place to place.

The third group, the Benthos, are animals and plants that are fixed to the bottom, or that live within circumscribed limits on the bottom, and are unable to migrate at will, nor can they be carried about by the sweep of a current or tide.

With regard to the Plankton, Professor Haeckel says, "With the exception of the deep-sea Keratosa, my own contributions to the 'Challenger' work concern the Plankton, and have proved that it is just the smallest pelagic animals which possess the greatest importance for oceanic life. As I wandered for ten years though this wonderful new empire, populated by more than four thousand species of Radiolaria, for the most part previously unknown, and as I daily admired the incredible variety and elegance of their delicate forms, I had the happy and proud sensations of the explorer who is the first to travel through a new continent peopled by thousands of new and curious forms of animals and plants." The abysmal deeps again contain a new world inhabited by Benthos, strangely-formed genera, and species who have slowly migrated through various environments to the ocean-depths.

In geology the information obtained regarding the deposits now forming on the ocean-floor has been of great importance, but those who hoped that the dredge would drag from the ocean caves "the monsters vast of ages past," and that the hauls would yield many living forms of Tertiary types, have been disappointed. The botanical work has been mainly in the direction of extending our knowledge of the flora of the oceanic areas at a distance from land-masses; and in some cases additional information has been recorded on the floras of the more remote islands. The results of the expedition

from a naval point of view are numerous and important, and more especially with regard to the delineation of the contour-curves of the great ocean-basins, and the series of memoirs on the oceanic circulation. The brilliant success of the "Challenger" expedition and its report gives us good ground for hoping that one of Her Majesty's ships might be employed in filling up some of the gaps which naturally occurred in the explorations, and that, above all, some assistance should be given to follow out the important lines of inquiry opened up by the results of the soundings taken in the southern seas in the neighbourhood of the Antarctic. As I have said on another occasion, important magnetic and meteorological problems demand investigation in the Antarctic, and I for one would desire to see British sailors set out from this British colony to once more force the icy gates of the South and beard the ice-king in his solitary realms.

## Art. XIX.—*A Comparison of the Magnetic Screening produced by Different Metals.*

By J. A. Erskine, M.A.

[*Read before the Philosophical Institute of Canterbury, 6th November, 1895.*]

When a conductor is placed in a varying magnetic field the currents induced in it tend to keep the field constant. If the field varies slowly the effect is slight; but in fields produced by rapidly-alternating currents the "screening" is very marked.

In these experiments the fields were produced by leyden-jar discharges. Magnetized steel needles were used as "detectors" (Rutherford, Trans. N.Z. Inst., 1894, p. 488). Magnetized steel needles are much more suitable for this purpose than unmagnetized, for a field too weak to magnetize a needle to any appreciable extent is capable of producing considerable demagnetization.

The discharge passed through a coil of several turns, inside which a magnetized steel needle was placed, and in whichever direction the needle lay it was partially demagnetized; but the demagnetization was greater when the needle was placed in that direction in which the field, due to the first semi-oscillation of the discharge, demagnetized it. Hereafter this direction will be referred to as "direction *a*"; the direction in which the field due to first semi-oscillation tended to magnetize the needle as "direction *b*."

If a metallic screen was placed inside the coil, so as to surround the needle, the demagnetization produced by the discharge was less.

The screening depends on the thickness and on the conductivity of the screen, and on the frequency of the discharge.

The condenser, which consisted of ordinary 40oz. leyden-jars, was charged by a Voss influence machine, and connected in series with several coils wound on glass tube of 21mm. diameter. In the circuit was a spark-gap, of length 3·7mm., and the diameter of the knobs was 2·8cm.; hence the potential at discharge was about 43·5 electrostatic units, or 13,000 volts. (J. J. Thomson, "Recent Researches," p. 77.) It was found that the effect of the discharge varied less with this length of spark than with a shorter spark.

The needles used were of glass-hard pianoforte-steel wire. They were magnetized to saturation by placing them in a coil (of 191 turns, and of length 9·9cm.) through which passed a current of from six to ten ampères, produced by a Grove's battery or by an accumulator. The needles, for convenience in handling, were sealed in fine glass tubes.

The needle, after being magnetized, was placed at a distance of 102·5cm. from the needle of a magnetometer. The magnetometer readings were taken by the ordinary lamp-and-scale method. The needle was then placed in one of the coils in the leyden-jar circuit and a discharge was passed. The needle was again tested by the magnetometer and the new reading noted. Great care had to be taken in replacing the needle, and in order to avoid error the magnetometer was kept in a fixed position throughout the experiments, while the needle was placed in a groove cut in a bar attached to a stand, which was itself screwed down to the table on which the instrument stood.

The screens were metal cylinders, which could be placed inside the coils. They were formed by winding thin sheets of metals on glass tubes.

Great care had to be taken to make the contact at the junction good; if there is merely touching contact the screening is much reduced.

The screening produced by different metals was compared as follows: Tubes were wound with different numbers of layers of tinfoil. The reductions in the deflection produced on the magnetized needle when surrounded by these and placed in a certain coil (of 2·04 turns per centimetre) were observed. Similar experiments were made with cylinders of other metals, and the numbers of layers of tinfoil producing the same effect were calculated by interpolation.

The diameter of the tubes on which the metals were wound was 14·4mm., and the length of metal 16cm. The

tinfoil was pasted on to the tubes. In the case of the other metals used—lead, zinc, silver, and copper—the junction was made by soldering. The only other metal that could be obtained in thin sheets was alúminium, and the difficulty in making a junction precluded its use. Unfortunately, only one thickness of each of the metals could be obtained, and that was so great that only one layer could be used

The thickness of the metals somewhat restricted the scope of these experiments, and rendered the method less sensitive than it would otherwise have been; while, in order to get sufficient reduction of deflection with the needle placed in direction *b*, it was necessary to use as a condenser four leyden-jars arranged in parallel. The thicknesses of the metals used were—

| | |
|---|---|
| Copper ... ... ... | 0·0134 millimetres. |
| Silver ... ... ... | 0·0108 " |
| Zinc ... ... ... | 0·0430 " |
| Lead ... ... ... | 0·0957 " |
| Tinfoil ... ... ... | 0·0116 " |

In the first set of experiments the condenser consisted of two leyden-jars arranged in parallel. The length of the needle used was 60·4mm., and it was placed in direction *a;* for with the needle placed in direction *b* the copper, zinc, and silver were thick enough to screen off all effect, while in the case of the lead the screening was at least 95 per cent. The observations made are here tabulated:—

| Number of Layers of Tinfoil. | Original Deflection. | Reduced Deflection. | Reduction. |
|---|---|---|---|
| 0 | 201 | 102 | 99 |
| 5 | 201 | 129½ | 71½ |
| 6 | 201 | 134 | 67 |
| 8 | 201 | 141 | 60 |
| 9 | 201 | 144 | 57 |
| 10 | 201 | 147 | 54 |

| Metal. | Original Deflection. | Reduced Deflection. | Reduction. |
|---|---|---|---|
| Silver .. .. | 201 | 141 | 60 |
| Copper .. .. | 201 | 144½ | 56½ |
| Zinc .. .. | 201 | 143¾ | 57¼ |
| Lead .. .. | 201 | 133 | 68 |

The results obtained from these observations were that the silver produced the same screening as 8 layers of tinfoil; that the copper was equivalent to 9·2 layers, the zinc to 8·8 layers, and the lead to 5·8 layers.

A second set of experiments was made with four leyden-jars, arranged in parallel, placed in the circuit, and the needle placed in direction *b*. The length of the needle used in this set of experiments was 74·5mm. The observations are here tabulated:—

| Number of Layers of Tinfoil. | Original Deflection. | Reduced Deflection. | Reduction. |
|---|---|---|---|
| 0 | 252 | 155½ | 96½ |
| 5 | 252 | 225½ | 26½ |
| 6 | 252 | 231 | 21 |
| 7 | 252 | 235 | 17 |
| 8 | 252 | 239 | 13 |
| 9 | 252 | 243 | 9 |
| 10 | 252 | 246½ | 5½ |
| 11 | 252 | 250 | 2 |
| 12 | 252 | 252 | 0 |

| Metal. | Original Deflection. | Reduced Deflection. | Reduction. |
|---|---|---|---|
| Silver | 252 | 241 | 11 |
| Copper | 252 | 244 | 8 |
| Zinc | 252 | 243 | 9 |
| Lead | 252 | 231½ | 20½ |

The results of this set of experiments were that the silver was equivalent to 8·5 layers of tinfoil, the copper to 9·3 layers, the zinc to 9 layers, and the lead to 6·1 layers.

These experiments show that the thicknesses of different metals required to produce the same screening are proportional to the specific resistances of the metals.

In the next table the equivalent thicknesses obtained by experiment are compared with those calculated by taking the thickness proportional to the specific resistance:—

| Metal. | Equivalent Number of Layers of Tinfoil. Deduced from First Set of Experiments. | Deduced from Second Set. | Deduced by taking Thickness Proportional to Sp. R. |
|---|---|---|---|
| Silver | 8·0 | 8·5 | 8·2 |
| Copper | 9·2 | 9·3 | 9·5 |
| Zinc | 8·8 | 9·0 | 8·7 |
| Lead | 5·8 | 6·1 | 5·6 |

Professor J. J. Thomson, in a paper on "The Resistance of Electrolytes to the Passage of very Rapidly-alternating

Currents" (Proceedings, Royal Society, 17th January, 1889, vol. xlv.), investigates mathematically the screening produced by a conducting-plate, and shows that it is proportional to the thickness, and that if plates of different metals produce the same screening their thicknesses will be proportional to their specific resistances.

The screening mentioned by Professor Thomson is measured by the decrease of electro-motive force, while in these experiments the screening is measured by the decrease of magnetic force; and it is possible to have very considerable screening of electro-motive force and at the same time very little screening of magnetic force, for the magnetic field may be large though its rate of change is small. Professor Thomson (see paper mentioned above) found that a thickness of $\frac{1}{1700}$ of a centimetre of Dutch metal screened off all electromotive force, and the thinnest films of metal he could obtain screened off all effect.

## Art. XX.—*Magnetic Viscosity.*

By E. Rutherford, M.A., B.Sc., 1851 Exhibition Science Scholar.

[*Read before the Philosophical Institute of Canterbury, 4th September, 1895.*]

This research was undertaken to see if steel or soft iron exhibited any appreciable magnetic viscosity when under the influence of very rapidly changing fields. Ewing had shown that there was a slow creeping-up of the magnetization for some seconds after the magnetizing force had been applied; but considerable difference of opinion has been expressed as to whether the area of the hysteresis curve would be less for a slow cycle than for a very rapid cycle of less than $\frac{1}{1000}$ of a second.

I had already designed the apparatus and the method of reducing the experiments before a copy of the Proceedings of the Royal Society, 20th April, 1893, reached New Zealand. I there found an account of experiments by Messrs. Hopkinson, Wilson, and Lydall, which in a great measure anticipated what I had intended doing. Later, when I received a copy of Gray's Absolute Measurements, I found an account of recent researches on the same subject (vol. ii., 753–758).

Messrs. Evershed and Vigneroles had shown that there was very little difference between the energy lost in magnetic

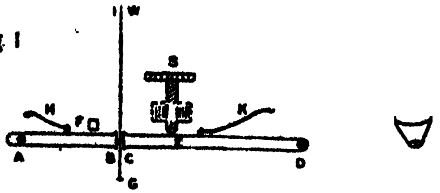
hysteresis at periods from 2 seconds to $\frac{1}{100}$ of a second. Hopkinson had obtained quite a marked difference between a slow and a rapid cycle, and had conclusively shown that the difference observed was not due to any time effect on the ballistic needle (Proc. Roy. Soc., 20th April, 1893). As the subject of the dissipation of energy due to magnetic hysteresis with varying periods is one of considerable interest, I determined to continue my experiments on the subject, especially as I was enabled to deal with intervals of time much shorter than those in Hopkinson's experiments.

In order to carry out these experiments a special form of apparatus for measuring short intervals of time was designed. It was necessary for the research to be able to measure the times of rise of currents in circuits whose self-induction was chiefly due to the amount of iron in the circuit. The "time-apparatus" was found to work very satisfactorily, and by its means time-intervals of less than $\frac{1}{100000}$ of a second could be with certainty determined.

DESCRIPTION OF THE TIME-APPARATUS.

A B, C D were two solid copper levers, pivoted at A and D respectively. The lever A B was kept pressed against a copper rod F by means of the spring H. The lever C D was kept pressed against the point E of a screw S by means

Fig. 1




of the spring K. A vertical nickel wire W G, of length 6ft., passed between the extremities B, C of the levers, and was tightly stretched. A falling weight L M slid freely on this vertical wire. The shape of this weight is shown on the right-hand side of Fig. 1. A hole passed longitudinally through the falling weight, and, in order to prevent undue friction, the hole in the centre of the mass of metal was larger than at the ends, so that the wire could only touch the metal at the extremities L M.

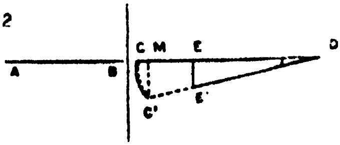
In order to hold up the falling weight at any height on the vertical wire an electro-magnet was made to slide on the wire, and was held in position at any point by a screw. On turning off the current the weight fell instantly without communicating any movement to the wire.

When the ends of the levers B, C were exactly in the same horizontal plane the falling weight knocked the levers

from E and F simultaneously. If by means of the screw S the lever C D was depressed below A B, the falling weight reached the lever A B first, and after a certain definite interval the lever C D.

The interval of time was calculated as follows :—

Fig 2




Let A B, C D be the two levers when horizontal. Let the screw be given $n$ turns, so that the lever C D is then in the position C′ D. Let E and E′ be the ends of the screw in the two positions. Let $\theta$ be the angle C D C′. Let $h$ = height of weight above the first lever. The velocity with which the weight reaches the lever A B is given by $\sqrt{2gh}$, assuming the body falls freely under the influence of gravity. As the distance between the levers was never greater than $\frac{1}{2}$in., and $h$ was generally 3ft., we may assume the velocity to be sensibly constant over the interval.

Let $d$ = distance between threads of screw :

$$\text{Then E E}' = nd.$$

Let C D = $l$; E D = $l_1$; let C′ M be vertical distance between the two levers :

$$\begin{aligned} C'M &= C'D \sin.\theta \\ &= l\frac{nd}{\sqrt{l_1^2 + n^2d^2}} \\ &\frac{l}{l_1}\cdot nd\left\{1 - \frac{1}{2}\frac{n^2d^2}{l_1^2} + \&c.\right\} \end{aligned}$$

Now, $nd$ in these experiments was never more than $\frac{1}{4}$in., and $l_1$ = 4·81in. The value of the correction due to C moving over the arc of a circle may therefore be neglected.

The time taken to move over the vertical distance C′ M, assuming velocity constant, is given by

$$t = \frac{ndl}{l_1\sqrt{2gh}}$$

In the actual experiments

$$\begin{aligned} d &= \tfrac{1}{40}\text{in.}; \\ l &= 6{\cdot}125\text{in.}; \\ l_1 &= 4{\cdot}81\text{in.}; \\ h &= 3\text{ft.}; \end{aligned}$$

$\therefore\ t = n \times 0{\cdot}000192$ nearly.

∴ the time to cross over an interval corresponding to one turn of the screw is 0·000192 seconds. The screw-head was

divided up into twenty divisions, and the apparatus was quite delicate enough to show a difference for every division of the screw-head when determining the times of rise of currents of very short duration.

The apparatus could therefore readily measure intervals of time up to $\frac{1}{100000}$ of a second.

Now, this gives the time-intervals as derived from theory. In practice the time-intervals corresponding to one turn must be slightly greater, due to the retardation of the falling weight. The causes of the retardation are—(1) friction of the wire against falling weight; (2) the work done in knocking away the *first* lever; (3) friction of air, &c. As the wire was well oiled and placed exactly vertical, cause (1) is very small; as the weight was very heavy compared with the lever A B, the correction for (2) cannot be very great; and (3) is quite insignificant.

Later, experimental verification will be given that the calculated values are very nearly the same as the true values.

For the success of the experiments it was not necessary that the *absolute* values of the time-intervals should be known, but only that successive turns of the screw should correspond to equal intervals of time, and this, from the nature of the instrument, is very nearly true.

In order to determine the hysteresis curve for soft iron and steel when the current varied very rapidly, the time of rise of the magnetizing current for soft iron and steel rings was obtained by use of the time-apparatus.

### ARRANGEMENT OF EXPERIMENT.

A battery of five Grove cells was connected to the binding-screws A and B of the time-apparatus. A wire led from B

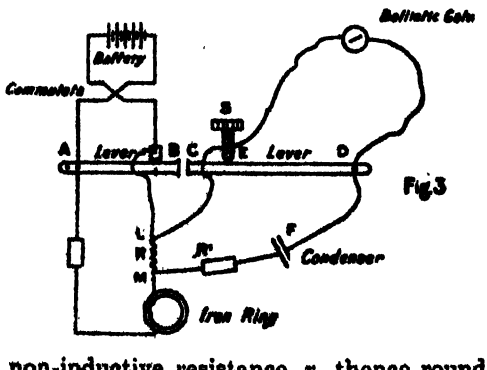



Fig.3

through a non-inductive resistance $r$, thence round the iron ring which is to be experimented on, and back through a resistance-box R to the binding-screw A.

From one terminal L of the non-inductive resistance $r$ a wire was taken to the back of the screw S. From the other terminal M a wire was led through a resistance-box R, and thence to one terminal of a $\frac{1}{3}$ microfarad condenser, the other terminal of which was connected to the binding-screw D in the lever of the time-apparatus.

A ballistic galvanometer was connected to S and D.

Since the levers A B, C D were of solid copper they acted as very low resistance shunts to the circuit R M L and the ballistic galvanometer respectively. When the battery current is turned on only a very minute amount of the current passes round the circuit L M R, since its resistance is many thousand times greater than that of the lever A B.

We may therefore assume, for all practical purposes, that when the shunt A B is in position there is no current round the circuit L M R.

(1.) Suppose the two levers to be exactly level, so that the falling weight knocks them from their contacts simultaneously: When the shunt A B is removed the current commences to rise in the circuit A M B, the equation of rise being given by

$$CR = E - \frac{dN}{dt}$$

where C = current at any instant;
R = total resistance in the circuit;
E = total E.M.F. of battery;
N = total induction through the iron ring.

In all experiments the inductance of the connecting wires was very small, and can be neglected. The E M F at the terminals of the non-inductive resistance $r$ is given at any instant by

$$e = Cr.$$

Since the shunt E D is knocked from its contact E at the same instant as A B, the whole quantity of electricity required to charge up the condenser to the steady difference of potential between the terminals L M of the non-inductive resistance $r$ flows through the ballistic galvanometer.

The throw of the galvanometer needle is therefore proportional to the maximum E.M.F. between the terminals L, M.

(2.) Now, suppose the lever C D is depressed by giving one turn to the screw:

On releasing the weight, the lever A B is knocked from B a certain definite interval before the lever C D is reached.

During the interval the current has been rising steadily in the circuit B M R.

The condenser is charged through the shunt E D, the E.M.F. $e$ between its coatings at any instant being proportional to the current in B M R.

(The wires connecting the non-inductive resistance $r$ to the condenser were short, so that we may assume, without any sensible error, that the difference of potential between the coatings of the condenser at any instant is equal to the E.M.F. between the terminals L and M of the resistance $r$.)

When the lever CD is reached, the remainder of the quantity of electricity required to charge up the condenser to the steady difference of potential passes through the galvanometer.

The throw of the galvanometer is therefore proportional to the value of $\frac{dN}{dt}$ at that instant.

By gradually increasing the distance between the levers by turning the screw we get a series of values corresponding to $\frac{dN}{dt}$ for different values of time.

When the current has fully risen $\frac{dN}{dt} = o$, so that we then get no throw in the galvanometer, as the whole quantity flows through the shunt. Since the value of $\frac{dN}{dt}$ is known at any instant, the induction N through the iron for that instant may be calculated, and, since the corresponding current is known, we have all the data required to plot out the hysteresis curve for a very rapid cycle.

### EXPERIMENTAL VERIFICATION.

In order to see to what degree of accuracy the time-apparatus could be depended on, the time of rise of the current in a *coil of known self-inductance* was compared with the theoretical time of rise as determined from the equation

$$\frac{E}{R}\left(1 - e^{-\frac{R}{L}\cdot t}\right)$$

The coefficient of self-induction L was very accurately determined. The mean value of L was found to be $2{\cdot}315 \times 10^7$cm. The period of the ballistic galvanometer needle in this and all succeeding experiments was 7 seconds. The sensitiveness of the shunt-levers of the time-apparatus was tested, and they were found to work perfectly, no correction having to be made.

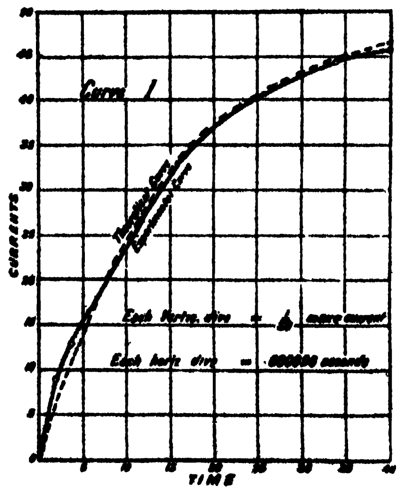
The resistance of the whole circuit was 15·65 ohms, and a battery of two Daniells's cells was used in this case.

The following are the results of a series of observations of the deflection of the galvanometer, and the number of turns of the screw at which the deflections were observed. Each observation is a mean of two experiments at least, and the curves in many cases were determined several times:—

| Turns of Screw. | | Throw of Galvanometer. |
|---|---|---|
| 0 | ... | $99\frac{1}{2}$ |
| 1 | .. | 82 |
| 2 | ... | 74 |
| 3 | .. | 65 |
| 4 | ... | $58\frac{1}{2}$ |
| 6 | ... | $46\frac{1}{4}$ |
| 8 | ... | $34\frac{1}{4}$ |
| 10 | ... | 25 |
| 13 | ... | $19\frac{1}{4}$ |
| 17 | ... | $12\frac{1}{4}$ |
| 20 | ... | $9\frac{1}{2}$ |

The current has here only risen to nine-tenths of its maximum value. It was not convenient to have the levers separated by more than twenty turns, so that the whole curve is not completely determined. It has been shown that the throw of the galvanometer at any instant is proportional to $\frac{dN}{dt}$ : *i.e.*, to $L\frac{dc}{dt}$ in the case of a coil of constant inductance L.

A curve can therefore be constructed whose abscissæ represent time and ordinates current. The theoretical curve of rise, calculated from the equation $CR = E - L\frac{dc}{dt}$, is plotted alongside the experimental curve.




The close agreement between the two curves shows that the time-apparatus may be relied on to give very accurate

results. It also shows that the time-intervals theoretically calculated are the true intervals, and that successive turns of the screw correspond very accurately to equal intervals of time.

TABLE FOR CURVES 1.

(Dotted curve is the theoretical curve, and the other the experimental curve.)

| Turns of Screw. | Observed Values. | Theoretical Values. |
|---|---|---|
| 2 | 8·8 | 6·1 |
| 4 | 12·8 | 11·45 |
| 6 | 17·8 | 16·15 |
| 8 | 20·7 | 20·3 |
| 12 | 26·8 | 27·1 |
| 16 | 32·9 | 33·3 |
| 20 | 37·6 | 36·4 |
| 26 | 40·5 | 40·8 |
| 34 | 44·1 | 44·5 |
| 40 | 45·5 | 46·3 |

In the experiments on magnetic viscosity rings of soft iron and steel were taken, and the times of rise of the magnetizing current determined as explained previously.

*Particulars of Soft-iron Ring.*

Composed of iron wire 0·008in. in diameter, wound into a ring and thoroughly insulated from eddy currents by shellac varnish.

Mean diameter of ring, 8cm.

Sectional area of ring, 0·079 sq. cm.

Wound with three sets of coils of 511 turns altogether.

The magnetizing force corresponding to one ampère of current round the ring was 25·5 C.G.S. units.

*Particulars of Steel Ring.*

Composed of fine steel wire 0·01in. in diameter, insulated with shellac varnish.

Mean diameter, 8·3cm.

Sectional area of ring, 0·14 sq. cm.

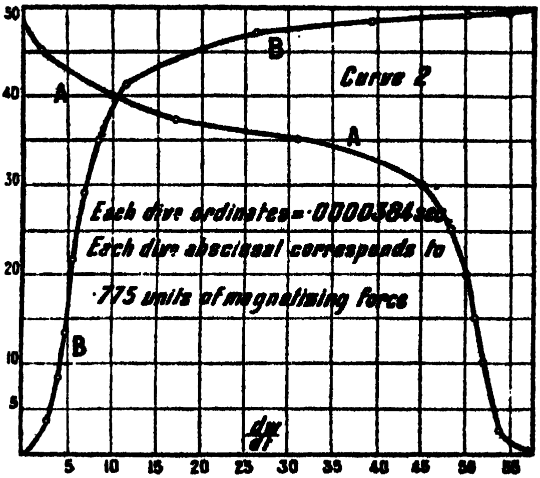
Wound with two sets of coils; total, 365 turns.

The static hysteresis curve for the soft iron and steel was very accurately determined. A special method was used, which allowed each individual point in the curve to be determined several times in succession.

From experiments with the time-apparatus it will be seen that the current rose to a maximum in the ring in about $\frac{1}{1000}$ of a second; so that the secondary current must have

all passed through the ballistic galvanometer long before there could have been any appreciable movement of the needle.

The hysteresis curve for the very rapid cycle was determined for the same maximum values of induction as the static curves, and under exactly the same conditions.



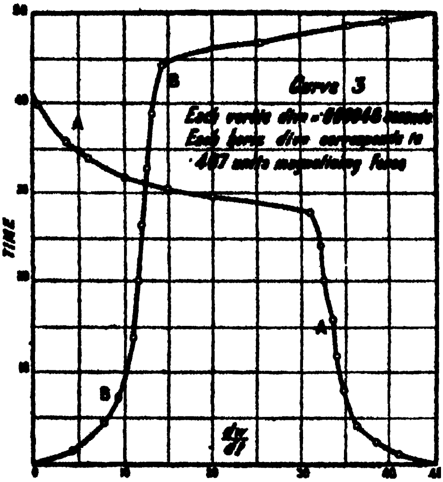

Curve 2 (A A) represents the relation between the values of $\frac{dN}{dt}$ and $t$ (time) for the soft-iron ring.

Since $\frac{dN}{dt}$* may be called the back E.M.F. in the circuit at any instant, when $t = o$, $\frac{dN}{dt} = E$, the total E.M.F. of the battery. The value of the current flowing in the circuit at any instant is therefore known when $\frac{dN}{dt}$ is known. It will be observed that the value of $\frac{dN}{dt}$ changes rapidly at the beginning, and then very slowly when the steep part of the hysteresis curve is reached. The value of $\frac{dN}{dt}$ changes again very rapidly at the point where the hysteresis curve bends over, and gradually falls to zero as the iron reaches its saturation-value for the maximum magnetizing force.

Curve 2 (B B) is deduced from the curve A A. If we take any point in the curve A, the magnetizing force is known, and the value of the total induction through the iron corresponding

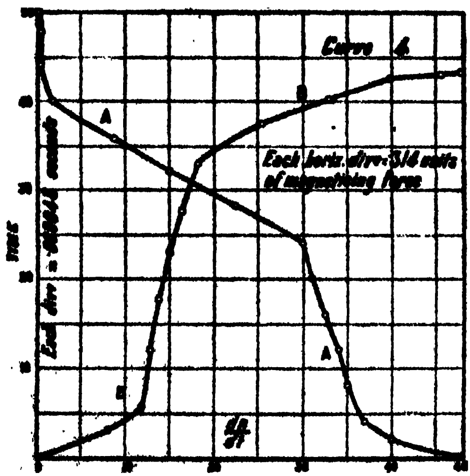
* In figures of curves erroneously printed as $\frac{dw}{dt}$ or $\frac{dn}{dt}$.

to that magnetizing force is proportional to the area of the curve included between the axes, the curve A A, and the abscissa drawn through the point.




The values of B and H for any point may thus be determined.

The ordinates of the curve B B are drawn proportional to the induction, and the abscissæ to the magnetizing force.




From the curve 2 (B B) curve 5 is plotted, showing the relation between B and H for the rapid cycle. The static ballistic curve is drawn alongside for comparison.

Curve 3 shows the corresponding relations for the steel-wire ring as curve 2 for the soft iron. Curve 6 shows the hysteresis curves for the slow and rapid cycles for soft steel. Curves 4 and 7 show the relations for a soft-iron ring when the maximum magnetizing forces is much lower than for the first two sets of curves. The value of H in this case was just sufficient to carry the magnetism of the iron up the steep part of the hysteresis curve.

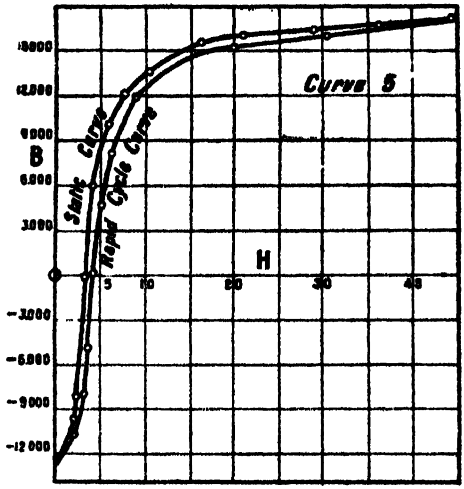



TABLE FOR CURVE 5.

| Static Ballistic Curve. Magnetizing Force = H. | Static Ballistic Curve. Total Induction = B. | Rapid-cycle Curve. Magnetizing Force = H. | Rapid-cycle Curve. Total Inducti[on] = B. |
|---|---|---|---|
| 0 | − 12936 | 0 | − 12936 |
| 2·35 | − 9884 | 2·5 | − 10709 |
| 2·75 | − 8316 | 3·46 | − 8060 |
| 3·76 | − 264 | 3·85 | − 4930 |
| 4·3 | + 5808 | 4·43 | − 115 |
| 6·21 | + 10032 | 5·39 | + 4467 |
| 8·1 | + 12016 | 6·74 | + 8013 |
| 10·53 | + 13464 | 9·05 | + 11806 |
| 16·62 | + 15492 | 20·21 | + 15117 |
| 21·05 | + 15840 | 30·61 | + 16080 |
| 29·14 | + 16304 | 36·38 | + 16682 |
| 44·4 | + 17168 | 42·54 | + 17103 |
| | | 43·7 | + 17132 |
| | | 44·4 | + 17162 |

Several more curves for soft iron and steel, with different maximum magnetizing forces and different periods, were also obtained, but, as they showed the same effect as the curves 5, 6, 7, they are not given here.

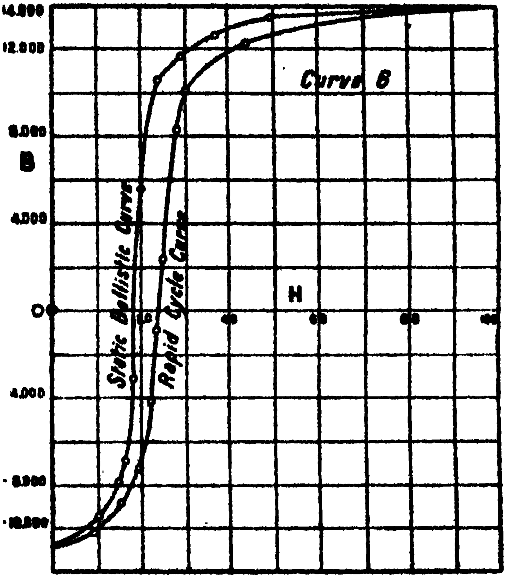
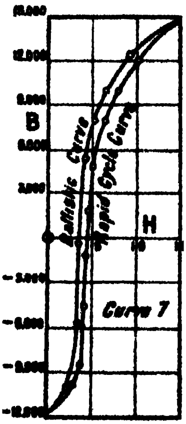



TABLE FOR CURVE 6.

| Static Ballistic Curve. | | Rapid-cycle Curve. | |
|---|---|---|---|
| Magnetizing Force = H. | Total Induction = B. | Magnetizing Force = H. | Total Inducti = B. |
| 0 | − 11076 | 0 | − 11076 |
| 7·8 | − 10127 | 9·54 | − 10826 |
| 10·63 | − 9638 | 15·91 | − 8826 |
| 12·45 | − 8946 | 20·1 | − 7474 |
| 14·94 | − 7881 | 23·22 | − 4076 |
| 16·6 | − 6890 | 24·34 | − 976 |
| 18·26 | − 3817 | 25·4 | + 2174 |
| 20·75 | + 5608 | 27·52 | + 5274 |
| 24·07 | + 10548 | 28·5 | + 8374 |
| 29·05 | + 11608 | 30·73 | + 10224 |
| 36·52 | + 12567 | 54·1 | + 12374 |
| 48·8 | + 13019 | 64·7 | + 12724 |
| 95·3 | + 13952 | 75 | + 13174 |
| | | 83·5 | + 13524 |
| | | 88·5 | + 13774 |

The general results of these experiments conclusively show that soft iron and steel exhibit quite appreciable magnetic viscosity in rapidly-changing fields. The effect is far more marked in the case of steel than in soft iron.

The greatest departure of the slow-cycle from the rapid-cycle curve is shown at the "knee" of the magnetizing curve.




When finely-divided iron or steel is subjected to rapidly-alternating currents the loss of energy due to magnetic hysteresis is greater than for slow cycles. In the case of steel the loss of energy would be quite 10 per cent. more than for slow cycles, and in soft iron not so much.

In later experiments it was shown that the effect observed was in no way due to any screening of the interior mass of metal from induction. The iron wire of which the ring was composed was of too small diameter to exhibit any appreciable screening effect, due to induced currents, for the period investigated.

TABLE FOR CURVE 7.

| Static Ballistic Curve. | | Rapid-cycle Curve. | |
|---|---|---|---|
| Magnetizing Force = H. | Total Induction = B. | Magnetizing Force = H. | Total Induction = B. |
| 0 | − 11952 | 0 | − 11952 |
| 2·1 | − 9992 | 2·61 | − 9845 |
| 3·21 | − 5680 | 3·71 | − 8546 |
| 3·68 | − 692 | 4·01 | − 4602 |
| 4·35 | + 5492 | 4·33 | − 1204 |
| 5·29 | + 7844 | 4·65 | + 1794 |
| 6·7 | + 10045 | 5·2 | + 4805 |
| 9·25 | + 12548 | 6·7 | + 7810 |
| 14·44 | + 14704 | 8·08 | + 10186 |
| | | 10·81 | + 12050 |
| | | 14·44 | + 14704 |

In my paper published last year (Trans. N.Z. Inst., xxvii., art. lix.) it was shown that iron could be magnetized and demagnetized when the magnetism was reversed more than 100,000,000 times per second. Soft iron and steel exhibit the effect of magnetic viscosity quite strongly for a frequency of 1,000; but whether the loss of energy due to hysteresis increases

with the period is not yet known. The molecule of iron can swing completely round in less than a hundred-millionth part of a second; but it is quite probable that the magnetizing force required to produce any given induction is considerably greater for a frequency of 100,000,000 than for a frequency of 1,000. For very rapid frequencies the screening effects are so great that only a very thin skin of the iron is magnetized, and the effect of successive oscillations makes the interpretation of the results very difficult.

### VARIOUS USES OF THE TIME-APPARATUS.

Not only was the time-apparatus a very simple means of determining the times of rise of currents in circuits when a steady E.M.F. was applied, but with different connections the duration of secondary induced currents at make and break of the primary could be examined under any conditions required. Very interesting information in regard to the screening effects of solid iron in rapidly-changing fields was deduced, and the subject of the gradual decay of magnetic force in magnetic and non-magnetic conductors, when the magnetizing force was removed, was experimentally verified. The behaviour of the magnetic metals when subjected to rapidly-changing fields is of great practical importance, and the need of very fine lamination of the iron for high rates of alternation is clearly shown in all the experiments.

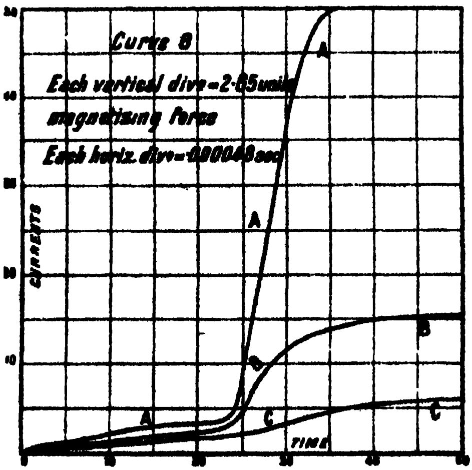
The principle of the time-apparatus can also be used to determine the velocity of projectiles at various points of their path. If two conductors, acting as shunts to the battery and galvanometer circuits respectively, be placed in the path of the projectile at a convenient distance apart, the time taken to traverse the distance between the two could be readily determined by observation of the amount of rise of the current during the interval. In a circuit of known inductance and resistance, the observed deflection of the galvanometer would be proportional to $e^{-\frac{R}{L}\cdot t}$; and, since $\frac{R}{L}$ is a constant for the circuit, $t$ could readily be determined, and thus the velocity known. This method is purely electrical, and is capable of great accuracy. The determination of the constants of the circuit is a simple matter, and there are no sources of error introduced.

### TIME OF RISE OF CURRENTS IN VARIOUS CIRCUITS.

In the experiments on magnetic viscosity the times of rise of currents in circuits containing iron were determined. It was observed that the nature of the curve of rise varied greatly

with the maximum current, and also depended on whether the iron in the circuit was solid or finely divided.

To illustrate the difference between the curves of rise for different maximum currents curve 8 is appended.




In curve 8 (A) the maximum magnetizing force is 132·6 C.G.S. units. After the steep part of the magnetizing curve is passed the current rises extremely rapidly, as is evident from the almost vertical line. Time of rise = 0·00173sec.

Curve 8 (B): Maximum magnetizing force, 38·7 units. None of the changes are so sudden as in the first curve. Time of rise = 0·00192sec.

Curve 8 (C): Magnetizing force, 15 units, which is just sufficient to ascend the steep part of the hysteresis curve. The current rises very gradually, and there are no sudden changes in the curve.

The times taken by the currents to rise in the three cases are nearly equal, notwithstanding the fact that the resistance in one case is nearly nine times that of the others.

In the above curves the iron was finely laminated, but when the iron is solid the current rises very rapidly for the first few ten-thousandths of a second, and then increases very slowly to its final value. This is due to the fact that only the surface-layers of the iron are magnetized at first, and the induction penetrates but slowly into the mass of the metal, due to the screening effect of induced currents.

With large solid electro-magnets the current takes in many cases over a second to rise to its maximum, and after

the first $\frac{1}{1000}$ of a second the curve of rise is nearly a straight line.

The curve of rise in the case of short cylindrical iron rods like the cores of induction-coils resembles very closely curve 1, for the inductance is sensibly constant.

If a closed secondary is wound over the primary the current rises much more rapidly than when the secondary is open, as we should expect from theory.

## DURATION OF INDUCED CURRENTS AT MAKE AND BREAK.

The time-apparatus could not only be used for determination of times of rise of currents in various circuits, but also for determining the duration of the current in the secondary at make and break.

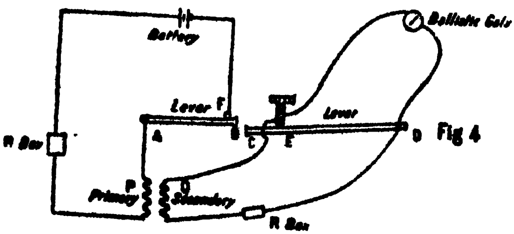



Fig 4

The method is a very simple one, and the duration of the secondary current may be determined under whatever conditions we please, since the resistance and inductance of the galvanometer does not affect the duration of the current in the circuit which is being experimented on.

One terminal of the battery is connected to F, and when the lever A B is in position the current passes along the lever B A, through the primary P, and through a resistance-box back to the other electrode of the battery.

The secondary circuit is connected through a resistance-box R and the shunt-lever C D. The ballistic galvanometer is a shunt off the lever E D.

The resistance in the secondary Q E D R may be adjusted to any required value.

When the falling weight is released, on reaching the lever A B it breaks the primary. The induced current at break commences to circulate in the secondary round the circuit Q E D R.

No appreciable part of the current flows through the galvanometer, as the resistance of the lever C D is extremely low.

When the weight reaches the lever C D it breaks the secondary circuit Q E D R, and the *remainder* of the quantity of electricity induced at break flows through the ballistic galvanometer.

By varying the turns of the screw—*i.e.*, the interval between the break of the primary and secondary—the quantity of electricity which has passed through the secondary during the different intervals is easily determined.

It must be noted that the galvanometer does not influence the curve so obtained, as the deflection of the galvanometer is proportional to the quantity of electricity which has passed *before* the galvanometer is placed in the circuit.

The duration of the induced current in the secondary is dependent on the self-induction and resistance: the greater the resistance the shorter the duration, and the greater the inductance the more prolonged the duration.

Let L and N be the self-inductance of the primary and secondary circuits respectively, and M the coefficient of mutual induction; let R and S be resistances of primary and secondary; let $x$ and $y$ be the currents in primary and secondary: If E be the E M F of the battery, the equation of rise in the primary is given by

$$L\frac{dx}{dt} + M\frac{dy}{dt} + Rx = E;$$

and the equation of rise in the secondary

$$N\frac{dy}{dt} + M\frac{dx}{dt} + Sy = o.$$

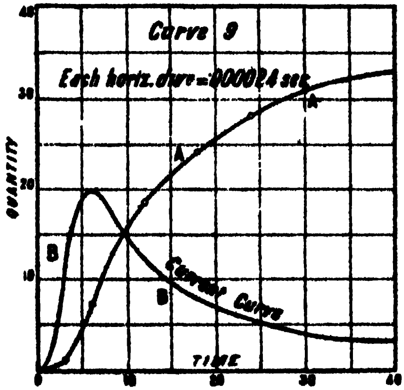
From these two equations $x$ and $y$ may be found when L, M, and N are constants. When iron, solid or finely divided, is in the circuit, the values of L, M, and N are variable, and the values of $x$ and $y$ cannot be determined.

The duration of the current in the secondary was determined under varying conditions of lamination of the iron, and a few of the more important results are given.

The duration of the induced current at break, when there was no iron in the circuit, was first examined. Two solenoids were wound over one another, and the secondary was of sufficient number of turns to give a convenient deflection in the ballistic galvanometer when the current was broken.

Curve 9 (A) shows the quantity of electricity that has passed in the secondary for different intervals of time.

Curve 9 (B) is the current-curve, and is deduced from 9 (A); for the current flowing in the circuit at any instant is given by $C = -\frac{dQ}{dt}$, where Q is the quantity of electricity that circulates in the secondary.

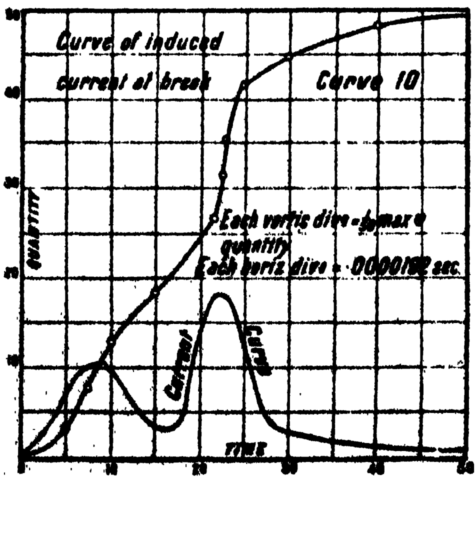



It will be observed that the current rises rapidly to a maximum, and then slowly decreases in value through a long interval of time.

When more than two-thirds of the quantity of electricity had already passed through the secondary, the slightest variation of the screw often caused large alterations in the deflection.

This irregularity in the deflections was evidently due to the fact that the current in the secondary was oscillating very rapidly.

It was not thought necessary to investigate the oscillations further, as the subject has been treated experimentally by Helmholtz, Schiller, and others.



Curve 10 shows what a marked difference there is in the current-curve in the secondary when iron is in the circuit.

A secondary was wound over the laminated core of a small induction-coil, and the duration of the secondary current determined. The current-curve exhibits two maxima, and is far more irregular than curve 9 (B). This was first thought to be due to some experimental error, but further investigations showed that the same peculiarity was exhibited by all the curves obtained. Curves were also obtained when finely-laminated iron and steel rings were used. The duration of the secondary could be varied by altering the resistance. When a large resistance was placed in the secondary the duration was very short. In the cases above considered the induced currents lasted about $\frac{1}{1000}$ of a second.

When solid iron is in the current the duration of the secondary is greatly prolonged, and is independent in a great measure of the *resistance* of the secondary.

A solid iron ring was taken and wound with appropriate magnetizing and ballistic coils. It was found that the secondary was of long duration. When 1,000 ohms were added to the current very little difference was observed.

If the lines of force had passed suddenly out of the primary, as in the case of the laminated core, the duration of the secondary induced current would have been diminished by increasing the resistance in the secondary; and yet in the case of the iron ring the effect was scarcely appreciable.

Clearly, then, the lines of force must pass out of the primary very slowly to account for the observed effect. The magnetic force in the iron changes very slowly when the current is broken, on account of the induced currents in the mass of the metal tending to prevent the decay of magnetic force through the iron.

### Decay of Magnetic Force in Iron and Copper Cylinders.

The very slow rate of decay of the magnetic force in an iron cylinder, which was observed in the experiments on the induced current at break, led to a series of more detailed experiments on the rate of decay of magnetic force when a uniform field was suddenly removed.

The subject is treated mathematically, p. 352–358, in Thomson's "Recent Researches," but I am not aware that the subject has been experimentally verified.

Suppose a metal cylinder be placed in a solenoid, and a steady current be sent round the solenoid. If the current is suddenly broken there are induced currents in the mass of the metal tending to maintain the original state of the magnetic field, and instead of sinking abruptly the field decays very slowly.

In order to experimentally test the rate of decay of induction in such a cylinder, a solenoid 10cm. long was wound uniformly with wire, ten turns to the centimetre. A secondary coil was wound over the primary, sufficient to give a convenient deflection in the galvanometer. On breaking the steady current flowing through the primary an induced current circulates through the secondary, and the duration of this secondary current depends on the resistance and inductance in the secondary circuit.

If sufficient non-inductive resistance be added in the secondary the duration of the induced current may be readily reduced to less than $\frac{1}{20000}$ of a second.

If the copper cylinder be now introduced into the solenoid the duration of the secondary is considerably prolonged, and its curve of rise and decay may be determined by the same method which has been used before.

The arrangement for the experiment is exactly the same as in fig. 4.

1,000 ohms non-inductive resistance was added in the secondary circuit, and the duration of the secondary was less than $\frac{1}{10000}$ of a second. The solid copper rod was now placed in the circuit, and at break the induced current was found to be considerably prolonged, due to the time taken for the magnetic force in the cylinder to decay.

From the fact that when there is no metal the whole current has passed in less than $\frac{1}{10000}$ of a second, we see that the current circulates in the secondary almost instantaneously after the lines of force pass out of the primary. When the copper cylinder is placed in the solenoid the quantity of electricity that flows in the secondary for any definite interval is proportional to the number of lines of force that have passed out of the primary in that interval.

Let N = total induction through secondary; let $a$ and $b$ be the areas of primary coil and copper cylinder respectively:

The induction through the copper $= \frac{b}{a} \cdot \mathrm{N}$.

The part of the induction $\mathrm{N}\left(1 - \frac{b}{a}\right)$ decays very suddenly; but the induction through the copper decays gradually.

On pages 356, 357, "Recent Researches," a table is given for the theoretical calculated values of the rate of decay for a series of values $\frac{t}{\mathrm{T}}$ where

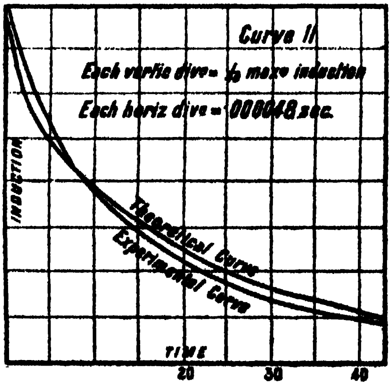
$$\mathrm{T} = \frac{4\pi\mu r^2}{\sigma}, \text{ where } r \text{ is radius of the cylinder.}$$

Now, for this experiment, assuming $\mu = 1$, $\sigma = 1{,}600$,

$$\mathrm{T} = 0{\cdot}0069\text{sec. approximately}:—$$

*Theoretical Table.*

| $\frac{t}{T}$ | Total Induction. |
|---|---|
| 0·00 | 1·0 |
| 0·02 | 0·7014 |
| 0·04 | 0·5904 |
| 0·06 | 0·5105 |
| 0·08 | 0·4470 |
| 0·10 | 0·3941 |
| 0·20 | 0·2178 |
| 0·30 | 0·1220 |
| 0·40 | 0·0684 |
| 0·50 | 0·0384 |




*Copper Cylinder.*

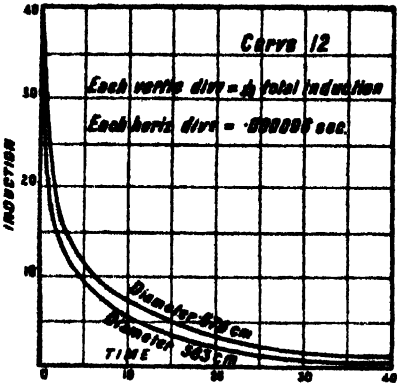
Curve 11 shows the rate of decay of the total induction through a copper cylinder 1·875cm. in diameter. The close agreement between the theoretical and experimental curves is a confirmation of the mathematical theory, for the difference between the two is quite within the limits of experimental error. The induction falls rapidly at first, and then very slowly, so that a long interval elapses before the induction has fully fallen.

In 0·00074sec. the induction has fallen to half its original value.

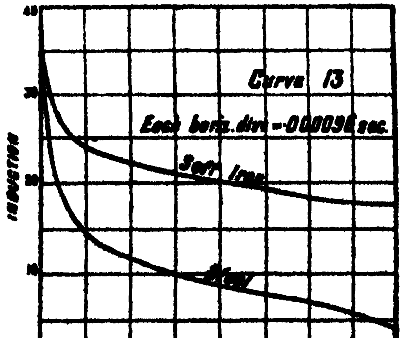
*Soft-iron Cylinders.*

Curve 12 shows the rate of decay of induction in soft-iron cylinders of diameter 0·676cm. and 0·573cm. respectively. The rate of decay is much slower than in the case of copper, on account of the high permeability of the iron, although the diameter and conductivity are less for the iron than the copper.

The greater the radius of the cylinder the longer the induction takes to decay.




In this case the induction falls extremely rapidly, and in about $\frac{1}{10000}$ of a second has fallen to half its original value. The subsidence of the remainder is much more gradual.




*Soft-iron and Steel Rings.*

Curve 13 shows the fall of induction for soft-iron and steel rings of sectional diameter 0·98cm. It will be observed that the rate of decay of the induction is much slower when the magnetic circuit is complete, as in the iron and steel rings, than in short cylinders of metal.

## SUMMARY OF RESULTS.

1. For finely-laminated iron, the lines of force pass out into the secondary circuit very rapidly after the magnetizing current is broken. It was experimentally shown that the

iron did not take more than $\frac{1}{10000}$ of a second for the rearrangement of the molecules into their final position; so that there is no appreciable time-effect in the demagnetization of finely-laminated iron.

2. In solid iron cores the induction decays very slowly compared with non-magnetic metals.

3. In iron and steel the decay is very rapid at first, and then very gradual.

4. The rate of decay of induction is more rapid in a short cylinder of iron than in a ring of the same dimensions, and is more rapid for steel than for soft iron of the same diameter.

5. The decay of induction in iron is purely due to the reaction-effect of induced currents in the mass of the metal, and is in no way due to any true time-effect in molecular rearrangement.

## II.—ZOOLOGY.

### Art. XXI.—*New Zealand Sponges: Third Paper.*

By H. B. Kirk, M.A.

[*Read before the Wellington Philosophical Society, 8th December, 1895.*]

Plates III. and IV.

It is proposed to deal in the present paper with the New Zealand Reticulate Ascons, so far as they are yet known to the writer. It is not necessary to review here the various schemes that have been proposed for the classification of these sponges. I simply state, therefore, that I follow the plan proposed by Bowerbank, and followed by Poléjaeff and others, of regarding the ascons as constituting a single genus, and adopt Dendy's subdivision into simple, reticulate, and radiate, and, with the modifications that I am about to mention, his further subdivision of the Reticulata. In Dr. Dendy's classification* the ingrowths of mesoderm, covered or not by collared cells, constitute an important feature. In the New Zealand ascons, at all events, this feature is too variable to be a reliable element in classification, and it is probable that the same variableness in this respect exists in the ascons of other countries. The mesodermal ingrowths may not be found at all in one specimen, and in another, undoubtedly of the same species, they may be found to be very well marked indeed. I think I am right in saying that Dr. Dendy does not now attach to this feature the weight that he attached to it when the Monograph was begun.

Abandoning this feature as an element in classification, Dr. Dendy's scheme, as applied to the New Zealand sponges, takes this form:—

Order Homocœla.

Genus **Leucosolenia.**

Section II. *Reticulata.*

Division I.—Pseudoderms not present. *Leucosolenia clathrus.*

Division II.—Pseudoderms present.

* See "Monograph of the Victorian Sponges," Trans. Roy. Soc. of Vict., vol. iii., p. 1.

Subdivision 1.—"The exhalent openings through which the water leaves the sponge are true oscula—*i.e.*, they lead directly into a space lined by collared cells, and formed by the union of a number of ascon-tubes."

| | |
|---|---|
| *Leucosolenia challengeri.* | *Leucosolenia intermedia.* |
| " *cerebrum.* | " *laxa.* |
| " *proxima.* | " *depressa.* |

Subdivision 2.—"The exhalent openings through which the water leaves the sponge are pseudoscula—*i.e.*, they lead at first into a space not lined by collared cells, but, presumably, by ectoderm. This space is a *pseudogaster*. It really lies outside the colony, and is formed, probably, by the upgrowth of the colony around it. The ascon-tubes open into the pseudogaster." *Leucosolenia rosea.*

I hope to have an opportunity, in a future paper, of making some remarks on the histology of the New Zealand reticulate ascons.

**Leucosolenia clathrus**, Schmidt. ("Supplement der Spongien des Adriatischen Meeres," p. 24.)

As Mr. Carter has pointed out,* Schmidt's sponge is not the one afterwards described and figured by Haeckel.† In Haeckel's sponge the ends of the spicules are obtusely rounded, or even knobbed, and the rays are often wavy.

I see no reason for regarding as different from *L. clathrus* a white ascon of considerable size that occurs freely along the shores of Cook Strait, in the neighbourhood of Wellington. Its spicules are more sharply pointed than the one figured by Schmidt; but they are almost exactly like those of a specimen, sent me by Dr. Dendy, of a sponge collected at Budleigh Salterton by Mr. Carter, and identified by him as Schmidt's *L. clathrus*. Moreover, the specimen referred to shows mesodermal ingrowths exactly like those of Wellington specimens—Dendy's type E. The sponge shows at death the colour-changes described by Carter.

I also place under *L. clathrus*, for the present at all events, the large white ascon that occurs so freely in Paterson's Inlet, Stewart Island. In this handsome sponge the spicules are often blunt, and approach those of *L. coriacea*, and the mesodermal ingrowths are less pronounced than in the Wellington sponge. Moreover, it differs from the Wellington sponge in the fact that its oscules are conspicuous, and borne at the apex of pronounced papillæ.

* A.M.N.H., 5, xiv., p. 17.

† "Kalkschwämme," ii., p. 30.

**Leucosolenia challengeri,** Pol. ("Report on the Calcarea of the 'Challenger' Expedition," p. 38.)

This sponge occurs in Cook Strait, in the neighbourhood of Wellington. The "Challenger" specimen is from Cape York. My specimens are all of the *Auloplegma* form. I have not yet seen the *Soleniscus* form, which is that of the "Challenger" specimen. Length of the sponge, as found near Wellington, about 20mm. Half the length is made up by the slender, solid peduncle. Of two specimens that I have sectioned, one has no mesodermal ingrowths, and the other has ingrowths of Dendy's type F.

**Leucosolenia cerebrum** (*Ascaltis cerebrum*), Haeckel. ("Kalkschwämme," ii., 54.)

A sponge with the apical rays of the 4-radiate spicules beautifully spined in their distal portion occurs—not very freely—in Cook Strait. These apical rays echinate the inner surface of the ascon-tubes in the usual manner. I have no hesitation in referring it to Haeckel's *Ascaltis cerebrum*. A pseudoderm is always present, so far as I have been able to observe, but I have not noticed the irregularity in the pseudodermal spicules referred to by Haeckel. I have found these spicules regular and massive, with the tips of the rays incurved in the regular tripod fashion. Size, 0·08mm. × 0·002mm. They closely resemble those of *L. intermedia* (Plate IV., fig. 2). Well-marked ingrowths of the mesoderm, of Dendy's type E, occur.

Haeckel's locality for this sponge is Lesina, in the Adriatic.

**Leucosolenia proxima,** Dendy.

If my identification of this sponge is right, it forms in New Zealand handsome yellow- or orange-coloured colonies from 10mm. to 25mm. in diameter, and with numerous oscules. The spicules of the pseudoderm have the rays slightly incurved, so that the centre is raised a little from the plane in which the points of the rays lie; the rays themselves taper rather less regularly than in the type, and they are a little more sharply pointed. It is quite possible that this is a different sponge from *L. proxima*, but at present I do not regard the differences as specific.

The canal system shows ingrowths of type E and also of type F.

The sponge forms colonies of two external characters: light-yellow in colour and loose in texture, and orange in colour and compact in texture. Slight differences in spiculation occur, but not constant and pronounced enough to justify,

according to my present view, the separation of the two forms, much as they appear at first sight to differ.

Locality: Cook Strait.

**Leucosolenia intermedia**, n. sp. (Plate IV., fig. 2.)

Sponge compact; yellow or yellowish-white when alive. Oscules numerous, each one at the apex of a small conical papilla: they often become obscured at death. There is a well-marked pseudoderm, characterized by stout tripod spicules. The spicules are all triradiates.

*Spicules:*—

The rays of the stout, pseudodermal spicules are strongly incurved, and are of about the same length as those of the deep spicules; they are blunt. The spicule forms a massive tripod, stouter than that of *L. tripodifera*, and with the rays a little more widely spread. Viewed from below, in certain positions the effect of perspective is to give a sagittal appearance that is illusive (figs. 2*d*–2*f*). A few stout 3-radiates are regular, and have straight rays (fig. 2*a*). Size, 0·13mm. × 0·04 mm.

The spicules of the deep parts of the sponge are regularly-tapering 3-radiates, with fairly sharp points. Size, 0·09mm. × 0·01mm. The canal system is of Dendy's type E.

In spiculation this sponge occupies a position intermediate between *L. pulcherrina* and *L. proxima*. From the former it is broadly distinguished by the fact that its pseudodermal spicules are larger instead of smaller than its deep ones, and from the latter by the marked tripod character of the pseudodermal spicules. This last characteristic seems also to distinguish it from *L. stipitata*.

Locality: Cook Strait.

**Leucosolenia laxa**, n. sp. (Plate IV., fig. 1.)

Texture loose; colour white. A pseudoderm, characterized by oxeote spicules, is present, but is not well developed except at the sides of the sponge. Mesodermal ingrowths occur sparingly, and they may or may not be covered by collared cells. Skeleton consisting of 3-radiate, 4-radiate, and oxeote spicules, the two former occurring throughout the sponge, and the last being confined to the pseudoderm, and echinating feebly the surface of the sponge.

*Spicules:*—

Triradiates: Regular; rays tapering evenly to a sharp point; 0·17mm. × 0·015mm.

Quadriradiates: Basal rays sometimes slightly curved, tapering evenly to a sharp point, 0·15mm. × 0·018mm.; apical ray straight, 0·1mm. × 0·018mm.

Oxea: Clavate, generally obtuse at both ends, uneven; 0·37mm. × 0·025mm.

This sponge is closely allied to Haeckel's *Ascandra reticulum*, from which, however, it may easily be distinguished by the character of its oxea. In *A. reticulum* these are fusiform, even in outline, and pointed at both ends. In *L. laxa* they are clavate, wavy in outline, and obtuse at the broader end, generally at both. Dr. Dendy's *L. dubia* is very like this sponge, but its quadriradiates are occasional and not constant.

The external appearance of this sponge is that of *L. clathrus*.

**Leucosolenia depressa**, Dendy. (Monograph.)

Occurs in the neighbourhood of Wellington.

**Leucosolenia rosea**, n. sp. (Plate III.)

This sponge forms spreading masses, which may attain a diameter of 75mm. The surface is for the most part remarkably even, but it rises into rounded lobes and ridges, along which the pseudoscula are placed. The pseudoscula are generally oval in shape, and are from 0·6mm. to 8mm. long. Around the margin of each is a pseudoscular membrane, slightly developed, and not rising above the general surface of the sponge. The pseudopores are evenly distributed over the whole surface. The pseudoscula open into pseudogasters. A colony often contains a large number of these spaces. The canal system is of Dendy's type D.

When alive the sponge is of a pale-pink or salmon colour, and the colour remains for a long time in dried specimens.

*Spicules*:—

Triradiates: The pseudoderm consists mainly of enormous 3-rayed spicules, which show an approach to the tripod condition. Their outline is often wavy, and the broadest part of the ray is often at about a third of the distance from the base to the point. The points of the rays are blunt. Length of ray, 0·3mm.; greatest breadth, 0·07mm.

Deep triradiates: The 3-radiates of the inner part of the sponge are regular and sharp-pointed; the rays tapering evenly. 0·2mm. × 0·018mm.

The triradiates of the wall of the pseudogaster, and especially those around the pseudosculum, often become sagittal, the oral rays being curved, either towards or away from each other, and the basal ray being shortened. In these regions of the sponge occurs a curious 2-rayed spicule, the third ray having failed to appear, or, having appeared, to develope. Fig. *h* shows a spicule in which the third ray is incipient.

Quadriradiates: These are generally rather smaller than the 3-radiates, and the main rays are a little less sharp. The

apical ray, however, is very slender, and sharply pointed: it is slightly curved. Basal rays, 0·14mm. × 0·01mm.; apical ray, 0·11mm. × 0·008mm.

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### EXPLANATION OF PLATES III. AND IV.

PLATE III.

*Leucosolenia rosea.*

*a–c*, spicules of pseudoderm.
*d, e*, regular 3-radiates of parenchyma.
*f, g*, sagittal 3-radiates.
*h–k*, arrested or abnormal spicules.
*l–n*, 4-radiates (*a.r.* = apical ray).

PLATE IV.

*Leucosolenia laxa.*

1*a*–1*c*, oxea of pseudoderm.
1*d*–1*f*, 3-radiates.
1*g*–1*i*, 4-radiates (*a.r.* = apical ray).

*Leucosolenia intermedia.*

2*a*, large regular radiate of pseudoderm.
2*b*–2*f*, pseudodermal "tripod" spicules viewed at different angles.
2*g*–2*h*, " " " in profile.
2*i*–2*j*, 3-radiates of parenchyma.

## ART. XXII.—*Notes on New Zealand Land Planarians: Part II.**

By ARTHUR DENDY, D.Sc., F.L.S., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 3rd July, 1895.*]

THE present contribution to our knowledge of the land planarians of New Zealand deals exclusively with a number of specimens collected during a month's stay at Springburn, at the foot of Mount Somers, in November and the early part of December of last year (1894). In the immediate vicinity of the thick bush-scrub of the Alford Forest the locality appeared a good hunting-ground for cryptozoic animals, and experience showed that this was indeed the case. The very luxuriance of the vegetation, however, with its unlimited hiding-places for cryptozoic animals, made the task of collection more difficult than it would have been in a clearer neighbourhood, where the animals are concentrated, as it were, in a comparatively few spots.

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* For Part I. see Trans. N.Z. Inst., vol. xxvii., art. xvii.

The majority of the species collected have already been described in the first part of these notes, but even concerning these a certain amount of additional information was obtained.

**Geoplana triangulata**, var. **australis**, Dendy.

This large, handsome variety was met with in abundance, being perhaps the commonest form in the locality. The colour of the dorsal surface was usually dark-purplish-brown in its median portion, while the margins and ventral surface ranged from pale-yellow to orange. Some specimens were found associated with dead beech-leaves, which, in their two prevailing shades of orange and dark-brown, almost exactly matched the colours of the planarians. Possibly we have here a case of protective resemblance. It is interesting to note that all the specimens found were without the dark speckling on the margins and ventral surface. Thus they agree with the Dunedin form. In Christchurch, on the other hand, none but the speckled form has yet been found, though the species is very common.

**Geoplana latissima**, n. sp.

When at rest, very broad and short, flattened, not triangular in section; when crawling, long and narrow, strongly convex above, flat beneath. Length of a specimen when crawling, 62mm.; breadth of another at rest, 11mm. Eyes small and rather few, arranged in almost single series around the anterior extremity.

Dorsal surface orange, shading into pinkish anterior tip, and with narrow yellow margins. A very narrow deeper-orange stripe may be visible in the mid-dorsal line in the posterior part of the body. Ventral surface very pale yellow, nearly white, without markings.

In spirit the shape of the body is very characteristic—very short and broad, and with the two ends curled in ventrally. The anterior end is bluntly pointed, hollowed underneath and convex above. The posterior end is much more bluntly rounded off, and has a slight median notch in the margin (present in four out of five specimens, the other being injured posteriorly). The very narrow lateral margins are thin and prominent, and slightly upturned. Both apertures are situate far back, the peripharyngeal at about the junction of the middle and posterior thirds, and the genital perhaps slightly nearer to it than to the posterior extremity.

At first sight this species resembles *Geoplana triangulata*, var. *australis*, but in life the orange colour is really very characteristic, while in spirit the shape of the body is still more so. It is the broadest land planarian in proportion to

its length which I have seen, the length in spirit being scarcely more than twice the breadth.

**Geoplana alfordensis**, n. sp.

When crawling, long and narrow, convex above and flattened below. One specimen measured, when crawling, about 33mm. in length by 2mm. in breadth. The ground-colour of the dorsal surface is very pale yellow, with a pair of rather broad dark-reddish or chestnut-brown stripes. The width of the median band of ground-colour varies a good deal in the three specimens. Anterior tip pink. Ventral surface very pale yellow, without markings. Eyes as usual, but comparatively few and inconspicuous.

In spirit the body is of approximately uniform width, except where it tapers just at the anterior and posterior extremities. It is oval in transverse section, convex dorsally and ventrally, and with rather prominent lateral margins. The peripharyngeal aperture is well behind the middle of the body. The position of the genital was not very satisfactorily determined.

**Geoplana purpurea**, Dendy.

I identify four specimens as a slight colour variety of this species. The colour in life was very dark brown, nearly black, on the dorsal surface, with narrow dirty-white median stripe. The ventral surface was lighter brown, and the anterior tip pale-brownish.

**Geoplana quinquelineata**, Fletcher and Hamilton.

I identify with this common Australian species two small specimens. The largest was only about 30mm. long when crawling. At rest, flattened on both surfaces, but not markedly quadrangular. Ground-colour very pale yellow all over, with five dark-grey stripes on the dorsal surface, the median one narrowest. Anterior tip pink.

**Geoplana graffii**, Dendy.

Three fairly typical, although rather small, examples of this species were met with.

**Geoplana graffii**, var. **somersii**, nov.

This variety, represented by three specimens, differs from the typical form in the suppression of the pale longitudinal bands on both surfaces. The body in spirit also appears to be narrower in proportion to its length, and hence less leaf-like. The colour is greyish-brown all over, with minute white specks; paler on the ventral surface, but also speckled. The white specks or dashes are more strongly developed in the mid-dorsal line than elsewhere, perhaps indicating the lost

median stripe. The peripharyngeal aperture in spirit is somewhat behind the middle, and the genital rather nearer to it than the posterior extremity.

**Geoplana iris**, n. sp.

Closely resembling *G. graffii*, to which it is evidently nearly allied, in size and shape and in the general markings of the dorsal surface, but differing strikingly in the details of pattern. In the mid-dorsal line is a rather narrow pale band of brownish-yellow or orange, sometimes edged with iridescent green. On each side of this is a broad band of dark chocolate-brown, in all specimens edged on the outside with iridescent blue, and about twice the width of the median band. This is followed again by a narrow marginal band of orange, which may also have greenish iridescence on its outer edge. The ventral surface is pale, dull orange, without markings. The anterior tip is dull-orange or dark pinkish-brown. The peripharyngeal aperture is decidedly behind the middle, and the genital about half-way between it and the posterior end.

**Geoplana inæqualistriata**, Dendy.

This species was originally described from a single specimen found crawling on an asphalt path near Christchurch, and it therefore gives me peculiar satisfaction to be able to record the discovery of a fine specimen in its native haunts, beneath a rotten log near the edge of the Alford Forest.

When at rest it was broad and flattened; when crawling, long but fairly broad, broader behind than in front, strongly convex above, flattened or concave below, measuring about 80mm. by 5mm. Dorsal surface brownish-grey with white stripe and dashes arranged exactly as in the type. Ventral surface white, with abundant small brownish-grey specks, which are absent from the prominent narrow margins, and almost absent from a narrow median band. Anterior tip pink. Eyes as usual. In spirit the body contracts but little. The ventral surface is slightly concave, with very prominent margins, the dorsal surface convex. The peripharyngeal aperture is situate decidedly behind the middle, but well in the middle third, and the genital aperture is at about one-third of the distance from it to the posterior end. The white markings became, in parts, distinctly yellow in spirit.

[Since the above was written I have found, on 30th June, another specimen of *G. inæqualistriata* in my garden at St. Albans, where the type specimen was obtained. The last-found specimen was lying under a large stone. I placed it in a tin collecting-box with some parsley leaves and left it on the verandah, intending to preserve it in spirit next day. There

was, however, a severe frost in the night, and the animal was dead and liquefying the next morning.]

**Geoplana subquadrangulata**, Dendy.

This common species is represented in the Springburn district by two varieties:—

(*a*.) Has the three dark stripes on the dorsal surface as usual, with abundant dark speckles between the median and paired stripes. The lateral surfaces also have numerous dark speckles, concentrated so as to form a discontinuous lateral stripe. The ventral surface is without speckles.

(*b*.) Is remarkable for the great breadth of the paired dorsal stripes, which extend inwards until they are separated from the median narrow stripe by only a very narrow band of ground-colour. The ground-colour is very pale yellow, the stripes dark-grey or olive-brown. The lateral surfaces are slightly speckled with grey; the ventral surface is not speckled.

Several specimens of each variety were met with.

**Geoplana mariæ**, Dendy.

This species, which was originally described from a single specimen from near the Otira Gorge, was not uncommon at Springburn. Its most striking characteristic is the shape of the body in spirit—very thick, strongly convex on both surfaces, and very blunt at both ends. Most, if not all, of the Springburn specimens exhibit a paler band at the junction of the dorsal and ventral surfaces. In my first description I compared the shape of the body to that of *G. fletcheri*, but this is a mistake, as it is really very different, especially in spirit. In the markedly posterior position of the apertures, however, there is a real resemblance between the two.

## Art. XXIII.—*Note on the Discovery of Living Specimens of* Geonemertes novæ-zealandiæ.

By Arthur Dendy, D.Sc., F.L.S., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 3rd July, 1895.*]

In the last volume of the "Transactions of the New Zealand Institute"* I described, under the name *Geonemertes novæ-zealandiæ*, the first specimens of a land nemertine ever re-

* Trans. N.Z. Inst., vol. xxvii., p. 192.

corded from these islands. Two specimens were described, both of which were found amongst spirit-preserved collections of land planarians, for which they had evidently been mistaken. No record has hitherto been made of the appearance of the living animal—indeed, it had never been recognised in the living state until I had the good fortune, in November last, to meet with two specimens in their native haunts. The animal was found under fallen and decaying timber, near the edge of the Alford Forest, at the foot of Mount Somers, and near the Township of Springburn (South Island), associated with land planarians and other cryptozoic animals. It is a curious fact that, even after minutely examining and describing the spirit specimens, I at first mistook the living animal for a planarian. So close is the general resemblance in habits, shape, and markings that I did not discover its true nature until I came to examine it more carefully at home. The following description of the living worm will perhaps help to prevent such mistakes in the future:—

The body, both when at rest and when crawling, is long and slender. The larger of the two specimens when at rest measured about 37mm. in length and 3mm. in breadth, and when crawling 53mm. in length and 2mm. in breadth. The head is rounded, not constricted off from the body, but distinguished by its colour. It bears a narrow vertical slit in front, which is the common opening of the mouth and proboscis-sheath. It also bears four eyes, which are easily recognisable in the living animal, and of which the two upper and inner are smaller and less distinct than the two lower and outer.

The ground-colour of the dorsal surface is pale-yellow, with four longitudinal stripes of dark purplish-brown. The dark stripes of the inner pair are broad, and separated from one another by a narrow median band of yellow; those of the outer pair are very narrow, and separated from the inner each by a very narrow yellow line. The narrow dark stripes lie very near the margins of the dorsal surface. The stripes all cease abruptly a short way behind the eyes, and the head is pale brownish-yellow, quite a distinct tint from the dorsal ground-colour. The ventral surface of the body is nearly white.

The animal crawls very slowly, and leaves behind it a slimy track. As it progresses the head is moved from side to side.

## Art. XXIV.—*New Zealand Diptera: No. 1.*

By P. Marshall, M.A., B.Sc., F.G.S., Lecturer on Natural Science, Lincoln College.

[*Read before the Philosophical Institute of Canterbury, 5th June, 1895.*]

Plates V.-VII.

When one considers the great geographical isolation of New Zealand, and the discoveries that have been made of remarkable types among the higher classes of animal life as represented here, it seems peculiar that such little attention has been paid to the collection and classification of the lower classes of animal life. Although one cannot hope to parallel the discoveries of the moa and *Sphenodon* among the lower and more humble representatives of the animal kingdom, yet it is only to be expected that some of the lower animals will show great and remarkable variation from those types that have been collected and described in Europe and America. Entomology seems to have suffered from neglect even more than the other branches of zoology; for, though we have—thanks to the labours of Captain Broun and Mr. Fereday—fairly complete descriptions and classifications of the Coleoptera and Lepidoptera, none but spasmodic attempts have been made to collect and describe any other of the large orders of insects. The Diptera especially have been neglected, probably owing to the inconspicuous nature, and the usually out-of-the-way habitats, of most of the species belonging to this order. In 1881 Captain Hutton collected all the descriptions that had been written of the insects captured in New Zealand during the voyages of the "Astrolabe" and other ships and expeditions in these waters. To these descriptions he added a few of his own, and published the whole collection as a catalogue of the Diptera of New Zealand, together with similar catalogues of the Orthoptera and Hymenoptera. Since that time a few dipterous insects have been described by different authors in the "Transactions of the New Zealand Institute," but the total number now described does not amount to more than a hundred and twenty-five species, of which only twenty belong to the Nemocera. In 1892 Mr. Hudson, of Wellington, published a "Manual of New Zealand Entomology," in which figures and observations on the life-history of several species were given. Amongst these were some new species; but no descriptions were given of them. Two years ago I commenced to make a collection of our native species of flies, intending at the time to send them to England to

have them named. On mentioning this to Captain Hutton he pointed out the disadvantages of having them named in Europe, and advised me to work them up myself. This task I have found even more difficult than I anticipated, and my comparative inexperience in the distinguishing and description of specific characters is the only apology for the inaccuracies and blunders that I must necessarily make in the following classification and description of those Diptera that I have been able to obtain. I intend to publish from time to time papers on the various families of Diptera. These I hope to supplement every year by species that have been discovered during the preceding year; so that, ultimately, these papers may perhaps attain to the completeness of monographs on the different families of Diptera.

The classification I have adopted is that used by Mr. F. A. A. Skuse in his papers on the Australian Diptera. These papers have in every case been the model to which I have endeavoured to attain, and I must here express my keen appreciation of the work he has done in collating and systematizing the writings and classifications of other dipterologists in Europe and elsewhere. He has certainly very greatly lightened the task of all subsequent workers at the Diptera in the Australasian Colonies. He has kindly assisted me in all cases where there seemed to me a doubtful issue, and has offered to afford me every assistance in his power. Many pages of these papers, more especially those that deal with the descriptions and classifications of the families and genera, have been taken almost directly from his papers, and he has generously acquiesced in this wholesale cribbing.

As far as possible, every genus will have a type-species illustrated by a diagram, giving a general idea of the appearance of the insect, and displaying those characteristics that are made use of in the classification of the particular group to which the insect belongs. In general these diagrams have been drawn from dried specimens, and do not, therefore, give with any exactitude the form of the abdomen and other soft parts that are liable to shrinkage during the progress of drying. For specific characters the diagrams, though drawn with considerable care, cannot always be trusted. It would, perhaps, have been better to have omitted drawing the body of the insect, and to have given diagrams illustrating the neuration of the wings alone, as done by Mr. Skuse; but my work has already shown how useful such diagrams may be if made use of with proper caution.

I very deeply regret that I am at present unacquainted with the life-history of any but a very few of the species that I shall describe. I shall be able, however, to give diagrams illustrating the life-history of what are, I hope, fairly typical

species of each of the families. These diagrams have in every case been drawn from living specimens. All the material that I at present possess has been collected by myself, chiefly in the neighbourhood of Lincoln College; but during the summer vacation many specimens have been collected in various widely-separated parts of the colony. I have not thought it advisable to arrange keys for reference until so many specimens have been collected that they may be considered to form a fair percentage of the total number of species in the colony.

In regard to collecting specimens, I have, like Mr. Skuse, found that glass tubes are the most suitable apparatus. Some bruised laurel-leaves should be placed in the bottom of the tube, and over these a layer of blotting-paper. This will absorb the moisture given off by the laurel-leaves, and therefore protect the insects from the injury that always results to them from contact with fluid. Most of the smaller and many of the larger species can be collected by placing the tubes over them with care whilst they are settled on some object. They will usually not rise until the tube completely covers them, and after a little fluttering about they will die. Specimens captured in this way should be fixed as soon as possible with gum on thin white cardboard. Gum of tragacanth, with a trace of corrosive sublimate, is the most suitable substance, as it does not cause any glaze on the surface of the cardboard. Only a very small spot of gum is necessary, and the legs and wings should be spread out as much as possible, but not at the risk of mutilating the specimen. The larger and more active insects can be easily caught with a gauze or muslin net of the ordinary make, but the net should not have a ring of too large diameter, otherwise it will be found exceedingly cumbrous in bush districts, where most of the Diptera Nemocera are found. I have collected large numbers of specimens from windows looking out on to shady and moist gardens. If the top is left slightly open it will be found that many insects enter and flutter about on the glass-panes, where they are very easily captured. I shall be very happy to supply glass tubes and other requisites to any one who will be good enough to catch a few of these insects for me.

The only literature I have been able to obtain on the Diptera are Walker's "Insecta Diptera Britannica," Theobald's "Account of British Flies," Hutton's "Catalogue of New Zealand Diptera," some of Osten-Sacken and Loew's "Monographs of the Diptera of North America," and Mr. Skuse's admirable "Monographs of the Australian Diptera." These last so ably summarise the work of the best-known American and European authors on the Diptera that I shall in every case adopt the classification employed in them, and thus render the New Zealand Diptera very easily comparable

with the Australian Diptera. Although I shall always regret not being able to obtain more works of reference, the papers that Mr. Skuse has written contain so much reliable information on the classification and arrangement of the genera that I feel I shall avoid most of the errors that would have been unavoidable without some firm basis and summary of other methods of classification.

The following table will show the classification adopted by Mr. Skuse, which is the one that I shall adhere to in my papers on the New Zealand Diptera :—

## Order DIPTERA.

### Section I. ORTHORHAPHA.

#### Division I. NEMATOCERA.

Subdivision 1. *Oligoneura.*

*Families.*—Cecidomyidæ, Sciaridæ, Mycetophilidæ, Simulidæ, Bibionidæ.

Subdivision 2. *Polyneura.*

*Families.*—Blepharoceridæ, Culicidæ, Chironomidæ, Orphnephilidæ, Psychodidæ, Tipulidæ, Dixidæ, Rhyphidæ.

#### Division II. BRACHYCERA.

Subdivision 1. *Cyclocera.*

*Families.* — Xylophagidæ, Cœnamyidæ, Stratiomyidæ, Acanthomeridæ, Tabanidæ.

Subdivision 2. *Orthocera.*

*Families.*—Leptidæ, Asilidæ, Midasidæ, Nemestrinidæ, Bombylidæ, Therevidæ, Scenopinidæ, Cyrtidæ, Empidæ, Dolichopodidæ, Lonchopteridæ.

### Section II. CYCLORHAPHA.

#### Division I. PROBOSCIDEA.

*Families.*—Syrphidæ, Myopidæ, Conopidæ, Pipunculidæ, Platypezidæ, Œstridæ, Tachinidæ, Dexidæ, Sarcophagidæ, Muscidæ, Anthomyzidæ, Cordyluridæ, Helomyzidæ, Sciomyzidæ, Psilidæ, Micropezidæ, Ortalidæ, Trypetidæ, Lonchæidæ, Sapromyzidæ, Phycodromidæ, Heteroneuridæ, Opomyzidæ, Sepsidæ, Diopsidæ, Piophilidæ, Ephydridæ, Geomyzidæ, Drosophilidæ, Oscinidæ, Agromyzidæ, Phytomyzidæ, Asteidæ, Borboridæ, Phoridæ.

#### Division II. EPROBOSCIDEA.

*Families.*—Hippoboscidæ, Nycteribidæ.

## Order DIPTERA.

Wings two, mesothoracic, membranous, with radiate veins; posterior wings wanting, represented by a pair of small clavate filaments called halteres; mouth suctorial; metamorphosis perfect; larva apodal; pupa inactive.

### Section I. ORTHORHAPHA.

The pupa-case opening longitudinally.

### Division I. NEMATOCERA.

The flies belonging to this division are characterized by the possession of long thread-like antennæ, consisting of several joints, in many instances oramented with whorls of long, delicate hairs, especially in the males. Nearly all are to be recognised without much difficulty by their long and slender body and limbs, small rounded head, and elevated thorax. As typical examples may be mentioned the mosquitoes (*Culicidæ*), daddy-long-legs (*Tipulidæ*), and midges (*Chironomidæ*). They are usually to be met with in all damp and shady situations, though they display considerable variety in habitat, appearance, and characters, as will be shown when the families are considered in detail. As these conditions in regard to habitat are thoroughly satisfied in many parts of New Zealand, it is only to be expected that we should possess an abundance of species and genera. The proper collection of the species would probably occupy many years, and the following papers will deal with what is probably quite a small percentage of the total number of species in the colony:—

Family 1. *Cecidomyidæ* (Gall Midges).—Small, delicate species. Antennæ generally long and necklace-like. Often no ocelli. Legs very long and slender; coxæ short; tibiæ slender, without spurs. Wings well haired, with very few veins. The larvæ are generally parasites on plants, but in a few cases live on dead vegetable matter beneath the bark of decaying trees. The irritation produced by the larvæ is frequently the cause of galls and other monstrous growths on plants. The perfect insects are found abundantly in shady places in forests, and are also frequent on window-panes facing shady or overgrown gardens.

Family 2. *Sciaridæ* (Shade Midges).—Generally small. Antennæ moderately long, curved, with cylindrical bead-like joints. Ocelli, three. Legs moderately long, slender; tibiæ with or without spurs. Wings often dark, usually without hairs, their neuration approaching that of the last family. The larvæ and pupæ are found in decaying vegetable matter, especially in rotten potatoes. Perfect insect very abundant during the whole summer, especially in damp, shady localities.

Much more active than the insects of the last family. The larvæ of some species have got the name of "army-worm" in Europe, from their habit of travelling together in large numbers. Represented by a large number of species in New Zealand.

Family 3. *Mycetophilidæ* (Fungus Gnats).—Size, small to moderate; usually rather robust. Ocelli, three or two. Antennæ short. Proboscis short. Legs rather long; coxæ elongated; tibiæ spurred. Wings often shaded, and sometimes pubescent; without discoidal cell, but neuration more elaborate than in the two preceding families. The majority of the larvæ live upon fungi or decaying vegetable matter. Some form a web of slimy material, and are occasionally phosphorescent. Perfect insect very active, and often capable of leaping. Found abundantly in damp and shady situations. Represented by several genera and numerous species in New Zealand.

Family 4. *Simulidæ* (Sandflies).—Size small. Body black, thick, and short. Antennæ cylindrical, short. Ocelli, none. All parts of the body fully developed. Legs short; hind tibiæ and first joint of the tarsus broad; tibiæ without spurs. Wings broad, abundantly but rather obscurely veined. The larvæ live in clear water, becoming fixed to plants when about to transform into pupæ. Perfect insect capable of inflicting severe wound. Found abundantly in all regions where there is clear or running water. The family contains only one genus, which is well represented in New Zealand.

Family 5. (*Bibionidæ*).—Moderate or small size. More robust than the preceding families. Antennæ short. Ocelli, three. Prothorax large. Wings large, but rather obscurely veined. Larvæ found on the ground or in dung. Perfect insects with a sluggish flight. Common on flowers. Very probably an archaic type.

Family 6. *Blepharoceridæ*.—Small. Antennæ long and slender. Eyes alike in both sexes. Ocelli, three. Legs long; coxæ short; posterior tibiæ generally with strong spurs. Wings broad and long, in neuration approaching the *Mycetophilidæ*. Skuse says very little is known of these species. I have not yet captured any specimens.

Family 7. *Culicidæ* (Mosquitoes).—Very slender; moderately sized. Antennæ moderately long. Mouth-parts of female containing all the organs found in the Diptera. Ocelli, none. Thorax stout. Legs long and slender. Wings slender, usually with scales; veins more than six in number. The larvæ are abundant in all stagnant water, in which they move with a peculiar jerking motion. The perfect insects are abundant in low-lying bush districts. The males feed on vegetable matter, especially honey. The females are capable

of inflicting a severe bite. Represented by a moderate number of species in New Zealand.

Family 8. *Chironomidæ* (Midges).—Small. Antennæ slender, beautifully adorned with hairs in the male. Proboscis fleshy and short. Ocelli, none. Abdomen and legs long and slender. Wings slender, veins as in *Culicidæ*, but no scales, though hairs are often present. Larvæ and pupæ generally aquatic, but some feed on dung and decaying vegetable matter. Perfect insect common in the neighbourhood of water. Some specimens capable of biting.

Family 9. *Orphnephilidæ.*—Small. Antennæ short. Ocelli absent. Proboscis little projecting. Thorax elevated. Legs rather short. Wings long and narrow; veins uniformly distinct. Little appears to be known of this family. I have no species belonging to it.

Family 10. *Psychodidæ* (Moth Midges).—Very small flies. Antennæ long, whorled with hairs. Ocelli, none. Body clothed with coarse hair. Legs rather long; tibiæ without spurs. Wings broad and hairy, with many longitudinal veins. Larvæ living in fungi and rotten wood. Perfect insect frequently found on walls and windows. Represented by a few species in New Zealand, one at least of which is very common.

Family 11. *Tipulidæ* (Daddy-long-legs).—The largest flies in this division, and in linear dimensions, if not in bulk, the largest flies of the order. Antennæ long and thread-like, often furnished with long hairs, or pectinated. Almost all without ocelli. Proboscis fleshy, rather prominent, and sometimes long. Thorax with a V-shaped transverse suture. Legs extremely long and fragile; tibiæ often spurred at the tip. Wings long, with a very complete neuration; discoidal cell present in most cases; basal cells very long. Larvæ and pupæ found in the ground, in rotten wood, in water, or in the leaves and stems of plants. Species extremely abundant in New Zealand, being found in numbers in all damp and shady situations.

Family 12. *Dixidæ.*—Medium-sized gnats. Antennæ long. Ocelli wanting. Proboscis rather prominent. Body slender. Legs long and slender. Wings somewhat large, occasionally spotted; six longitudinal veins; discoidal cell wanting. Larvæ aquatic. I have only found three specimens in New Zealand, all of which were taken on windows. According to Skuse they are common in Australia.

Family 13. *Rhyphidæ.*—Moderate-sized flies. Antennæ moderately long. Ocelli, three. Legs rather long and slender. Wings rather long and broad, with a discoidal cell. This family contains a single genus. The larvæ feed on vegetable matter, cow-dung, &c. Perfect insects found in outhouses and

sheds, in damp, dark places in bush, also in caves, and in similar localities.

### KEY TO THE FAMILIES OF NEMOCERA.

A. Thorax without any transverse suture.
- *a.* Tibiæ not spurred.
  - * Wings haired.
    - Longitudinal veins few. *Cecidomyidæ*, 1.
    - Longitudinal veins numerous. *Psychodidæ*, 10.
  - ** Wings naked.
    - § No ocelli.
      1. Legs hairy; antennæ with not more than 12 joints.
         - Costal vein continued round the margin of the wing. *Culicidæ*, 7.
         - Costal vein terminating near the apex of the wing. *Chironomidæ*, 8.
      2. Legs rather short; antennæ short.
         - Costal vein continued round the posterior border. *Orphnephilidæ*, 9.
      3. Legs short; antennæ with not less than 12 joints. *Simulidæ*, 4.
    - §§ Ocelli present.
      - No discoidal cell. *Bibionidæ*, 5.
      - A discoidal cell. *Rhyphidæ*, 13.
- *b.* Tibiæ spurred.
  - § No ocelli.
    - All tibiæ spurred. *Dixidæ*, 12.
  - §§ Ocelli present.
    - Anterior tibiæ spurred. *Blepharoceridæ*, 6.
    - All tibiæ spurred. *Mycetophilidæ*, 3.
    - With or without spurs. *Sciaridæ*, 2.

B. Thorax with a V-shaped transverse suture. *Tipulidæ*, 11.

## TERMINOLOGY.

As regards the technical terms employed, I feel I cannot do better than transcribe the following pages from Skuse's paper. The terms described are those made use of by Osten-Sacken and Loew in their monographs of the Diptera of North America.

### 1. *The Head.*

The back of the head opposite the thorax is the occiput, and is prominently perceptible in both Diptera and Hymenoptera carrying their heads free. That portion of it lying over the attachment of the head is the nape (*cervix*). The front forehead or brow (*frons*) is that part of the head stretching from the antennæ as far as the occiput, and is limited laterally by the compound eyes. The crown (*vertex*) is that part of the head on which there are usually the simple eyes (*ocelli*), generally three in number. The limit between the occiput and front is styled the vertical margin (*margo verticalis*). Most of those Diptera undergoing their metamorphosis within

the lower skin possess, immediately above the antennæ, an arcuated impression-line, which seems to separate from the front a small, usually crescent-shaped piece termed the frontal crescent (*lunula frontalis*). When the eyes meet on the front so as to divide it into two triangles the superior one is called the vertical triangle (*triangulum verticale*), the inferior the frontal triangle (*triangulum frontale*). The anterior portion of the head, reaching from the antennæ to the border of the mouth or oral margin (*peristomium*), is the face (*facies*). The antennæ are separated into two series of joints, the first consisting of the two basal joints, called the joints of the *scapus*, and the following those of the *flagellum*. Beneath the antennæ there are sometimes found longitudinal grooves (*foveæ antennalis*) for their reception. The sides of the head from the eyes downwards are called the cheeks (*genæ*). A somewhat swollen ring sometimes surrounds or partly encompasses the swollen eyes, and is termed the orbit (*orbita*), the successive parts of which are the anterior (*orbita anterior sive facialis*), inferior (*inferior s. genalis*), posterior (*posterior s. occipitalis*), superior (*superior s. verticalis*), and frontal (*frontalis*) orbits. Where no such ring is visible a distinct colour or some peculiar structure marking the nearest surroundings of the eyes is described on the orbit. The parts of the mouth (*os*) employed for sucking are called the sucker or proboscis; when attached to a long and generally cylindrical projection of the head it is called a snout (*rostrum*), and must be distinguished from a true proboscis. They may project from a wide aperture occupying a great part of the under-surface of the head, called the mouth-hole (*cavitas oris*). The common fleshy root of the oral parts is connected by a membrane with the border of the mouth. This membrane has a shield sometimes almost carneous; it is then termed the clypeus, or shield (*clypeus prælabrum*). It is either entirely connected by the anterior border of the mouth, and is then movable, or it projects over it as a ridge, and it is then generally immovable. Generally the largest of the mouth-parts is the fleshy underlip (*labium* or *hypostoma*), made up of the stem (*stipes*) and the knob (*capitulum labii*), formed of two suctorial flaps (*labella*). Close by are to be seen the *palpi*, which are important to notice, being frequently very characteristic. The tongue (*lingua*); upper jaws (*mandibulæ*), lower jaws (*maxillæ*), and upper lip (*labrum*) are not only inconspicuous, but generally difficult to recognise, and are rarely of value in distinguishing species. According to Meinert, the pharynx is separate from the first metamere, on which the labium and labrum are situated; on the second metamere the maxillæ and their palpi are placed; while on the third are situated the mandibles.

## 2. *The Thorax.*

The mesothorax is very largely developed in this Order, being so much larger than the prothorax and metathorax that it forms the greater part of this division of the insect's body. On account of this it is designated the thorax, different names being given to characteristic parts of the prothorax and metathorax. The former frequently forms a neck-like prolongation that bears the head, and is then called the neck (*collum*). In some cases the four corners of the mesothorax, or the shoulders (*humeri*), are covered by a lobe of the prothorax (*lobus prothoracis humeralis*), distinctly separated from the mesothorax. If this lobe be so soldered to the mesothorax that it is impossible to detect a distinct line between them, except in their general colour or hair, it is styled the shoulder callosity (*callus humeralis*). When the prothorax applies closely to the anterior border of the mesothorax it has then the name of collar (*collare*). An important character in its presence or absence is a transverse furrow (*sutura transversalis*) frequently found crossing the middle of the upper side of the mesothorax, and terminating on each side just before the base of the wing. On each side of the breast, beneath the shoulder, there is a spiracle (*stigma prothoracis*). The plate on the side of the breast is called the *pleura*. The scutcheon (*scutellum*) is separated from the back of the mesothorax by a furrow, and is situated between the wings. A part of the metathorax is to be found beneath the scutellum; it is called the metanotum. It generally descends obliquely, is often convex, and has on each side a more-or-less inflated space, called the lateral callosity of the metanotum. The poisers, or *halteres*, have their origin beneath this callosity, and in front of each of them we find the spiracle of the metathorax. The membranous covers sometimes found above this spiracle have the name of covering-scales (*squamæ* or *tegulæ*).

## 3. *The Abdomen.*

The upper side is generally so called, the name of belly (*venter*) being given to the lower side. The terminal joint is furnished in the male with appendages destined to take hold of the female *in copula*, and if they take hold in the form of pincers and these are not bent under the body they are called *forceps*; in the female, with the organ for laying eggs (*ovipositor*), which may be either called the bearer (*tenebra*) or the style (*stylus*), according to its shape.

## 4. *The Wings.*

These organs need more close and special study than any others in the distinction of species. The diagram (Plate VII.,

fig. 4) illustrating the veins and cells of the dipterous wing is wholly ideal, and combines all the characters that are found in the different families of the Order. The parts to which the numbers refer are named in the explanation of the plate. Some observations as to the relative value of the different veins and cells in describing characters of genera and species are given in Skuse's paper on the Australian *Cecidomyidæ* (vol. iii., Trans. Lin. Soc. N.S.W.).

## Family CECIDOMYIDÆ.

### 1. *Ovum.*

Longer than broad, ends rounded, orange-red, yellow, or whitish. The eggs are laid on the surface of leaves, in the flowers of grasses, or beneath the bark of trees. The larva usually escapes in a few days. In some species there is a single annual generation, but in others eggs are laid at two or more distinct times of the year. I have never been fortunate enough to observe the eggs on any plants, but some of my specimens deposited eggs after capture.

### 2. *Larva.*

The larva is rather a slender maggot, generally white in colour, but often orange or red. The body consists of fourteen segments, most of which are provided with stigmata. Head is small and retractile, provided with soft and rudimentary mouth-organs. A slender, corneous organ usually projects from the first thoracic segment. This is called the anchor process, or breast-bone. The function of this organ is not yet certainly determined. Baron Osten-Sacken remarks that its homology is unknown, and suggests that it is used for locomotion. He points out that it may represent the mentum, and is therefore homologous with the boring mentum of the larvæ of some *Tipulidæ.* Miss Ormerod suggests that the organ is used to injure plant-tissues, in order that the nutritive juices may be obtained more readily and in greater abundance. The terminal segment of the body is frequently provided with stiff hairs, that aid apparently in locomotion.

Some of the species undergo their metamorphosis from larva to pupa in cocoons; others bury themselves in the ground; while others have no special covering, and undergo the change in the same place in which they have completed their larval growth.

Many years ago parthenogenesis was described in cecidomyid larvæ. It appears to be of much the same nature as that so well known in the various species of *Aphis* flies. The ovaries of the larvæ develope fully, and produce six or more buds. These also grow and again produce buds, from

which a new generation developes. Sometimes as many as five generations can be distinguished beneath the transparent skin of a larva.

### 3. *Pupa.*

In the pupa nearly all the organs of the imago can be distinguished—eyes, antennæ, wings, legs, all being easily discernible. The insects appear to remain a very short time in the pupa stage.

### 4. *Perfect Insect.*

Skuse states that, so far as his observations go, the insect lives but a short time in the perfect state. With that conclusion the observations I have made on our New Zealand species lead me to concur unreservedly. The insects are particularly abundant in early spring, especially in the mornings and evenings. They can be found in numbers in all dark and shady places, many of them entering open windows that face shrubberies and being easily caught on the glass panes. Some species, however, can be found throughout the summer, but the number of species commonly found in summer is very much less than the numbers to be found in the spring. Their flight is usually feeble, and is never in a direct line, the insect darting hither and thither all the time it is on the wing. They do not seem to fly any distance, but the wind is probably a very important factor in their distribution. Mr. Skuse describes the extraordinary habits these insects have in New South Wales of hanging in cobwebs and vibrating in such a manner as to become more inconspicuous. Owing probably to hasty observation, I have never found them in such situations. I deeply regret that I have hitherto been unable to spare the time to investigate the life-history of any of the native species of *Cecidomyidæ*. The larvæ, as is well known, are usually parasites on the foliage of flowering-plants. As a result of the irritation produced by the larvæ on the tissues of the plant, monstrous growths, or galls, are produced.

As regards the geographical distribution of these flies, it may be said that species occur in every region of the globe where the Diptera have been investigated. In Australia Mr. Skuse has described ninety-five species, which he says represent in all probability but a very small proportion of the total number of species present in that country. Up to the present time no species have been described from New Zealand, but the present paper contains descriptions of twenty-three species. As these have all been collected within twelve months, the total number of species in the colony would probably be considerably over a hundred. These insects offer many difficulties to the collector, for, in the first place, their size is so minute that it is frequently a matter of no small

difficulty to see them with the naked eye. On account of their fragile nature they are extremely hard to set, and if left in a glass tube where there is any trace of moisture they quickly become dismembered, and their wings are injured. It is advisable to carry the materials for setting the insects whilst collecting, as one can then be sure of setting good specimens still uninjured. If in my excursions last summer I had been provident enough to carry the materials for setting with me I should probably have double the present number of species to describe. During the forthcoming spring and summer, however, I hope to profit largely by my experience of last year.

*Structure of Imago.*

The head is small, broader than long; round when viewed from the front. Eyes generally lunate or reniform, more or less contiguous on the front. Ocelli wanting in the sub-family *Cecidomyina*, but extant in the *Lestremina*. Proboscis short, thick, fleshy, directed towards the pectus. Palpi prominent, four-jointed, the first joint short, the last usually the longest. Antennæ long, moniliform or cylindrical, generally verticillate-pilose, seldom without verticils, ten- to thirty-six-jointed, of which the basal joints are more or less cupuliform; flagellar joints sometimes pedicelled in the male and sessile in the female, sometimes of the same structure in both sexes. The thorax rounded, in some species gibbose, sometimes extending over the head in the form of a hood; without a transverse suture. Halteres never completely bare, often considerably haired or scaled; the pedicel long and slender, the club large. Legs generally very long and slender; coxæ short, femora not thickened, tibiæ without spurs, tarsi five-jointed, the metatarsal joint much shortened in the first sub-family; claws weakly developed, with apparently only one cushion. Wings incumbent, proportionately long and broad, rounded at the apex, cuneiformly narrowed at the base; as a rule hyaline, though sometimes pellucid, with a pale bluish or brownish tint; generally beautifully iridescent; sometimes marmorated; more or less covered with irregularly-arranged hairs; occasionally scaly; all the anterior margin scalous; deeply ciliated at the apex and posterior margin. The number of longitudinal veins amounts to at least two, or at most five—never less than four in the second sub-family, or more than four in the first sub-family. In both sub-families the last two longitudinal veins coalesce for more than half their length, forming beyond a more or less distinct part. The additional longitudinal vein of the *Lestremina* is inserted between the second and third veins of the first sub-family, and is furcate in all genera but *Campylomyza*. A longitudinal

wing-fold generally has its position just in front of the third longitudinal vein, and often partially encloses the latter, or, less frequently, obscures it entirely from view. No species has more than one transverse or cross vein, which lies between the first and second longitudinal vein; but it is frequently most indistinct, or sometimes altogether wanting. Abdomen elongate, composed of nine segments; in the male cylindrical, provided with large holding-forceps; in the female acuminate, with a protruding or non-protruding ovipositor, rarely without two small lamellæ. The whole body with a covering of fine, delicate hairs, or less frequently scales or scaly hairs, the latter occurring more often on the under-surface of the abdomen and legs.

The prevailing body-colours seem to be shades of yellow and red, darkening into brown proportionately as the integument becomes more horny. The expanse of the largest species exceeds four lines, while that of the smallest is less than a line. Regarding the relative numbers of the two sexes, the females seem to be far more abundant than the males.

## CLASSIFICATION.

Skuse gives an excellent summary of the systems of classification of this family that have been adopted by previous authors, and for information on these I must refer to his paper. The following is the classification he adopts, and the one that will be adopted in this paper:—

### Sub-family I. *Cecidomyina.*

Wings with not more than four longitudinal veins, the two last frequently combining in the beginning of their course, forming a more or less distinct fork. No ocelli. First tarsal joint much shortened.

Genus 1. *Heterapeza.*

Antennæ moniliform or sessile, 2 + 8 or 9 jointed. Legs short; third joint of tarsus very long. Wings with two longitudinal veins.

Genus 2. *Miastor.*

Antennæ 2 + 11 jointed, verticillate in the male. Legs slender in male, but more robust in female. Wings almost bare, with three longitudinal veins.

Genus 3. *Cecidomyia.*

Antennæ long generally, verticillate, 2 + 9 to 2 + 36 jointed. Wings with three or four longitudinal veins.

Section I. Wings with three longitudinal veins, the third either forming a fork or becoming more or less obsolete towards the tip.

Sub-section A. Cross-vein, if present, placed between the root and tip of the first longitudinal vein.

Sub-genus 1. *Gonioclema* (Skuse).

Antennæ of female 2+11 jointed, verticillate, pilose. Second longitudinal reaching margin at the apex of the wing; cross-vein distinct; third longitudinal not branched.

Sub-genus 2. *Cecidomyia* (Loew).

Second longitudinal vein reaches the margin of the wing a little before its tip. Generally the same number of joints in male and female, the joints being pedicelled or sessile.

Sub-genus 3. *Diplosis* (Loew).

Second longitudinal vein reaches the margin of the wing at or beyond its tip. Antennæ of male 2+24 jointed; joints pedicelled; single joints alternating with double ones, or all joints simple. Antennæ of female 2+12 jointed; joints cylindrical, pedicelled.

Sub-genus 4. *Asphondylia* (Loew).

Second logitudinal vein reaches the margin of the wing a little beyond its tip. Antennæ of both sexes with the same number of joints; the latter cylindrical, sessile, with a short pubescence and without verticils.

Sub-genus 5. *Hormomyia* (Loew).

Second longitudinal vein reaches the margin of the wing either at or beyond the tip. Thorax more or less gibbose, frequently extending over the head in the form of a hood. Joints of male antennæ pedicelled, those of female pedicelled or sessile.

Sub-genus 6. *Necrophlebia* (Skuse).

Second longitudinal vein reaching margin of wing beyond its tip; third longitudinal vein without anterior branch. Antennæ in female 2+12 jointed; joints pedicelled, with two verticils.

Sub-genus 7. *Chastomera* (Skuse).

First longitudinal vein very wide of costa; second longitudinal reaching margin beyond apex of wing; no trace of anterior branch of fourth longitudinal. Antennæ in female pedicelled, verticillate.

Sub-genus 8. *Colpodia* (Winn).

Second longitudinal vein forms a curve before the cross-vein, and joins the margin a little beyond the tip of the wing; cross-vein rather long, oblique.

Sub-section B Cross-vein very oblique, originating at the root of the first longitudinal vein.

Sub-genus 9. *Dirhiza* (Loew).

Second longitudinal vein hardly undulating before the cross-vein. Joints of antennæ sessile, or almost sessile, in both sexes.

Sub-genus 10. *Epidosis* (Loew).

Second longitudinal vein sinuous before the cross-vein. Joints of antennæ pedicelled in both sexes; number variable.

Section II. Wings with four longitudinal veins.

Sub-genus 11. *Asynapta* (Loew).

Cross-vein sometimes like that in Section A, then the second longitudinal is not sinuated; sometimes as in Section B, second longitudinal is then sinuated.

Genus 4. *Spaniocera* (Winn).

Antennæ filiform, 2 + 11 jointed; joints cylindrical, without verticils. Second longitudinal vein reaching the margin considerably before the apex.

Genus 5. *Lasioptera* (Meig).

Antennæ 2 + 14 to 2 + 32 jointed; joints sessile, with short verticils. Three longitudinal veins, the first and second so near the costa as to be hardly discernible.

Sub-genus *Clinorhyncha* (Loew). Mouth prolonged into rostrum.

Sub-family II. *Lestremina.*

Wings with at least four longitudinal veins and at most five, sometimes with a rudimentary vein behind the fifth; the additional vein is situated between the second and third of the last sub-family. Ocelli nearly always present. First tarsal joint not shortened.

Genus 1. *Campylomyza* (Meig).

Fourth longitudinal vein forked. Antennæ 11 – 20 jointed; joints pedicelled in both sexes in some species—in some male pedicelled, female sessile, in others both sessile.

Genus 2. *Tritozyga* (Loew).

The upper branch of the fork forms a curve almost in the shape of an S.

Genus 3. *Catocha* (Hol.).

The upper branch of the fork forms a single smooth curve. Male antennæ 16-jointed, verticillate, joints pedicelled; female antennæ 10-jointed, pilose.

Genus 4. *Lestremia.*

Second longitudinal vein joining the margin much before the apex of the wing; third longitudinal with a very long fork.

Genus 5. *Cecidogona.*

Antennæ 2 + 9 jointed; joints verticillate, with very short pedicels. Second longitudinal reaching margin close to apex; branches of third longitudinal very long, almost parallel to one another.

The number of genera and sub-genera at present represented by specimens in my collection is comparatively small, but I have no doubt that many vacant spaces will before long be filled up. The entire classification of species at present known is given above, so that little difficulty will be experienced in classifying species that may be discovered subsequently. In the descriptions given below I have only mentioned those various divisions that are represented by species in my collection. I have not yet discovered any species of *Cecidomyia. Campylomyza*, on the other hand, is represented by several species.

Sub-family I. CECIDOMYINA.

Wings with not more than four longitudinal veins, the two last frequently combining in the middle of their course, forming a more or less distinct fork. No ocelli. First tarsal joint much shortened.

Genus 2. Miastor, Meinert.

Eyes separated in both sexes by a broad forehead. Antennæ 2+11 jointed; the basal joints cupuliform; the flagellar joints in the male ovate, with short pedicels and long verticillate hairs; in the female moniliform, subsessile, with short verticils. Prothorax arched. Legs slender in the male, shorter in the female; the tarsal joints of unequal length. Wings almost bare, appearing granulate under a high power. Three longitudinal veins; cross-vein sometimes present.

*Miastor agricolæ.* Plate V., fig. 1.

Antennæ, 0·026; expanse of wing, 0·033 × 0·013; length of body, 0·030in. Antennæ nearly black, nearly as long as the body, oval, becoming nearly globose towards the tip; last joint elliptical; verticils moderately long. Thorax nearly black,

with a few long black hairs, becoming fuscous towards the abdomen. Scutellum pink. Halteres whitish, thinly clothed with black hairs; club moderate. Abdomen dull-red, moderately haired. Legs dusky-yellow; first, third, and fifth joints about equal length, slightly longer than the fourth, second nearly twice as long as the first; clothed with moderate black hairs. Wings hyaline, with a few scattered black hairs on the surface. First longitudinal vein one-third the length of the wing, dark-brown; second longitudinal apparently arises some distance below first longitudinal, at about one-third of its length; third longitudinal close to margin, very indistinct before joining with it.

I am rather doubtful as to whether this species is classified correctly. I hope to obtain other specimens during the ensuing summer, and make another more detailed examination.

*Miastor difficilis*, n. sp.

Antennæ, 0·027; expanse of wing, 0·045 × 0·016; body, 0·027 × 0·005. Antennæ light-grey, as long as the body; joints near the base elongate, elliptical, about twice the length of the pedicels, becoming nearly globose towards the tip; verticils about twice the length of the joints, spreading. Thorax dark-brown, a few long hairs, without any apparent arrangement, arising from it. Scutellum brown in the centre, bordered with grey. Halteres white, with long pedicels; club large, elongate, pyriform in shape. Abdomen with first two segments nearly black, remainder orange-red, sparingly clothed with dark hairs. Legs pale-yellow, with numerous short black hairs; first joint of tarsus very short, others indistinguishable from one another. Wings hyaline, slightly hairy. First longitudinal vein indistinct, close to costa, about one-third the length of the wing; second longitudinal vein arising from about a third of length of first longitudinal, some distance below it; third longitudinal close to margin, bends sharply downwards before ending in the margin.

I have only a single specimen of this insect. I am not quite satisfied as to its position. (Lincoln, January.)

### Genus 3. CECIDOMYIA, Meig.

Antennæ long, moniliform or cylindrical, generally verticillate, rarely without verticils, from 2 + 9 to 2 + 36 jointed. Wings with three or four longitudinal veins, generally a longitudinal fold between the second and third longitudinal veins.

#### *Section I.*

Wings with three longitudinal veins, the third either forming a fork or becoming more or less obsolete towards the tip.

*Subsection A.*

Cross-vein, if present, placed between the root and tip of the first longitudinal vein.

Sub-genus 2. *Cecidomyia*, Loew.—Antennæ 2+9 to 2+22 jointed; generally the same number of joints in the male and female; joints pedicelled or sessile alike in both sexes, or pedicelled in the male and sessile in the female.

*Cecidomyia destructor*, Say. (Plate V., fig. 2.)—Length, 3mm. Eyes brownish-black. Front of head black, and clothed with long black hairs. Palpi yellowish, of four joints, partly covered by minute black scales, entirely covering the terminal joint. Antennæ yellowish-brown to almost black, composed of seventeen joints, with short black verticillate hairs; the first two joints very thick, first cup-shaped, second globular, third smooth, cylindrical, and elongated, gradually becoming smaller and ending in a long tapering point longer than any of the preceding. Proboscis minute, and rose-coloured. Thorax black, with grey tints in certain lights; white hairs on the sides, and also scattered on the ventral region. Scutellum black, hairy. Halteres yellowish-pink, with occasional black scales. A light-red line running from the neck to the base of the wing, along the side of the thorax. Abdomen pinkish, consisting of eight segments; the first segment is nearly black, the remaining segments are marked by a large square black spot on each side—these nearly unite on the seventh and eighth segments; the last two segments have a curious V-shaped marking, with two small lines, one on each side of it, and placed on a somewhat darker area than the general colour of the segments. Oviduct pale-reddish, yellow-brownish at the tip, composed of three joints; the last is pointed, and without lamellæ. Legs pink to light-red, clothed with black hairs. Second longitudinal nearly straight, then bends down and reaches margin before apex.

This insect has occurred in the colony within recent years. It is undoubtedly introduced. I have seen no specimens.

Sub-genus 3. *Diplosis*.—Second longitudinal vein reaching the margin of the wing either at or beyond the apex. Antennæ of the male 2 + 24 jointed; joints pedicelled; simple joints alternating with the double ones, or all the joints quite simple—in the latter case the joints only have one hair-whorl; joints sometimes with the hair-whorls equally long on the upper and under sides; often decorated with long stiff hairs on the upper side. Antennæ of the female 2 + 12 jointed; joints subsessile, or having very

short pedicels, cylindrical. Wings either unspotted or variegated.

A. Second Longitudinal Vein reaching the Margin of the Wing at or before the Apex.

1. Flagellar joints of the antennæ alternately singly and doubly jointed.

*a.* Wings unspotted.

*Diplosis dubia*, n. sp. (Plate V., fig. 3.) Female. Antennæ, 0·033; expanse of wing, 0·060 × 0·024; body, 0·036 × 0·010. Antennæ dark-brown, the two basal joints of the flagellum being longer than the others; all the joints cylindrical, the pedicels being half the length of the joints; verticils small. Front part of thorax black, becoming ferruginous-brown posteriorly. Scutellum ferruginous. Halteres white; pedicels long, with rather small pyriform clubs, clothed, like the pedicels, with scattered black hairs. Abdomen ferruginous-brown, with a few hairs giving silvery reflections. Legs long, clothed with black hairs giving silvery reflections; femora longer than the tibiæ; first joint of tarsus very short, second joint four or five times the length of the first, third about one-third the length of the second, fourth and fifth slightly shorter than the third. Wings with yellowish tinge, very small hairs. Veins yellowish; first longitudinal one-third length of the wing, close to costa; second longitudinal joining margin just before the apex; transverse vein joins first longitudinal at two-thirds of its length from the base.

I have only one specimen, taken at Lincoln, October.

*Diplosis difficilis*, n. sp. Male. Length of antennæ, 0·064; expanse of wings, 0·055 × 0·019; body, 0·031 × 0·005. Antennæ brownish, with moderately-long black verticils; double joints about the same length as their pedicels, but single joints considerably shorter; last joint ending in an appendage about as long as its pedicel. Head black, smooth. Thorax yellowish-brown, darker anteriorly; a patch of black curved hairs on each shoulder, but otherwise surface of thorax smooth. Scutellum light yellowish-brown, smooth. Halteres with long pedicels ending in a comparatively small club; dirty-white in colour, clothed sparingly with black hairs. Abdomen yellowish-brown; posterior part of the segments darker, clothed with black hairs, giving silver reflections. Legs about three times the length of the body, slender, light-yellow, but appearing nearly black from the large number of black hairs situated on them; tibiæ slightly swollen at the tip. Wings hyaline, with slight yellowish tinge. Veins brownish; first longitudinal ending a little before half the distance along the costa; second longitudinal reaching the

margin of the wing at the apex; branch of third longitudinal very indistinct. Surface of wings clothed with long black hairs; fringe long.

I have only one specimen, of a male insect. (Lincoln, February.)

*Diplosis melana*, n. sp.—Antennæ, 0·035; expanse of wing, 0·077 × 0·029; body, 0·033 × 0·020. Antennæ dark-brown; joints of flagellum cylindrical, more than twice the length of their pedicels, ornamented with a few short verticillate hairs; terminal joints slightly shorter than the others, and conical in shape. Head black, with short hairs rising from its posterior border. Thorax black, and hairless except for a few tufts arising from the shoulders. Scutellum dark-grey. Abdomen black, ferruginous on the flanks; a few hairs on the sides of the segments with silvery reflections. Halteres with short pedicels clothed all over with black and grey hairs; club pyriform, small. Legs moderately long, dark-brown, covered rather thinly with black hairs; femora rather stout; tarsi lighter in colour than the proximal joints. Wings with a grey tinge, a few short hairs scattered over their surface. Veins yellowish-brown except the second longitudinal, which is black; first longitudinal joining the costa about half-way from the base of the wing, the transverse vein, which is almost colourless, joining it at about two-thirds of its length; second longitudinal reaching the margin at the apex of the wing; apex of forks of third longitudinal below end of second longitudinal.

I have only one female specimen. (Lincoln, November.)

*Diplosis minuta*, n. sp. Female. Antennæ, 0·026; expanse of wings, 0·050 × 0·018; body, 0·030 × 0·011. Antennæ black; joints of flagellum with short pedicels, about one-third the length of the joints; cylindrical, ornamented with short black verticils. Anterior portion of thorax black, becoming red towards the extremity; a few white scattered hairs on its surface. Scutellum red. Halteres with slender pedicels; club small, pyriform, covered like the pedicels with scattered black hairs. Abdomen with the anterior segments dark-brown, but becoming red towards the posterior end; a few scattered hairs with silvery reflections situated on its surface. Legs rather short, dull-yellow in colour, covered with hairs black in colour but giving silvery reflections; tibiæ slightly shorter than the femora; first and fifth joints of the tarsus about the same length, second joint about twice the length of the third, which is longer than the fourth. Wings hyaline, with yellow reflections. Costa and second longitudinal dark-brown in colour, the others light-grey; first longitudinal ending at about one-third along the costa; second longitudinal ending at the apex; branch of third longitudinal forms

very acute angle with the trunk. Wings covered with slight pubescence.

Separated from *D. dubia* by shorter legs and smaller size; from *D. difficilis* by character of hairs on wings. (Lincoln, November.)

**B. Second Longitudinal Vein reaching the Margin of the Wing beyond the Apex.**

*Diplosis fragilis*, n. sp. (Plate VII., fig. 3.) Male. Antennæ, 0·049; wings, 0·066 × 0·027; body, 0·033 × 0·006. Antennæ with the joints longer than their pedicels, double joints nearly the same length as their pedicels; sub-globose; double joints cylindrical, with transverse suture, smoky-grey in colour; verticils not numerous, moderately long, black. Thorax ferruginous, dark in front but becoming lighter posteriorly. Scutellum semicircular, opaque, white. Halteres with long slender white pedicels; club pyriform, with small conspicuous thick black hairs. Abdomen with first segment ferruginous, the two succeeding segments much darker; the usual scattered hairs are present arranged on the posterior borders of the segments. Legs long and slender, light-yellow; femur and tibia about equal in length; first joint of the tarsus very short, second slightly shorter than the tibia, other joints much shorter, the fifth being the shortest. Wings perfectly hyaline, a few short black hairs being scattered over the surface. First longitudinal about one-third the length of the wing, marginal cross-veins situated half-way along it; second longitudinal at first straight, but afterwards strongly arcuated, ending a little beyond the apex; apex of feet of third longitudinal situated exactly below the end of the first longitudinal.

I have several specimens, collected at Lincoln during November and December.

*Diplosis hirta*, n. sp. Female. Antennæ, 0·033; wings, 0·071 × 0·027; body, 0·038 × 0·011. Antennæ dark-brown; joints of scapus fuscous; flagellar joints about twice the length of their pedicels, with one circle of long black verticils attached to the base; joints cylindrical, but constricted in the middle; terminal joint with distinct projection from its end. Thorax dark-brown, with two tufts of long black hairs arising on each lateral margin. Scutellum opaque, white. Halteres with long pedicels bearing a club thickly covered with black hairs. Abdomen dark-brown, with its segments much more hairy than in the other species. Legs dark-brown or black, covered with short black hairs—these are longer on the femora than elsewhere; joints of the legs as in *D. fragilis*. Wings smoky, their surface very densely covered with a brown pubescence; long, stiff, black hairs project from the costa, and there is a deep fringe extending right round the

posterior border of the wing. First longitudinal less than one-half the length of the wing; second longitudinal arcuated at the tip, ends slightly beyond the apex; anterior branch of third longitudinal very indistinct; transverse vein situated less than half-way along the first longitudinal.

I have two specimens, taken at Lincoln during November.

*Diplosis scoparia*, n. sp. Female. Antennæ, 0·036; wings, 0·088 × 0·038; body, 0·059 × 0·012. Antennæ dark-brown; joints about twice the length of their pedicels, cylindrical in shape, but slightly constricted in the middle; verticils short and scattered; terminal joint of the antennæ bears a pointed projection at its end. Palpi pink. Thorax dark-brown, with two narrow pink stripes, widely separated at the anterior end, but converging considerably towards the scutellum; a few hairs on the lateral margins and on the pink stripes. Scutellum pink, with a row of hairs on its semicircular posterior margin. Halteres with long slender red pedicels, bearing a pyriform club clothed rather thickly with black hairs. Abdomen bright-pink, the posterior margins of the segments, as usual, bearing a few long hairs. Legs dark-brown; femora and tibiæ about equal in length; joints of the tarsus as in *D. fragilis*. Wings smoky, rather thickly covered with a brown pubescence. First longitudinal rather less than half the length of the wing; second longitudinal at first straight, but afterwards strongly arcuated, ending considerably beyond the apex; fork of third longitudinal slightly beyond the end of first longitudinal; cross-vein situated less than half-way along first longitudinal.

I have two female specimens of this insect, which were taken at Lincoln in November.

*Diplosis wanganuiensis*, n. sp. (Plate VII., fig. 2.) Female. Antennæ, 0·049; wings, 0·096 × 0·035; body, 0·071 × 0·014. Antennæ dark-brown; joints of the scapus dull-yellow, nearly orbicular; basal joints of the flagellum more than double the length of those near the apex; basal joints much more, and apical joints slightly more, than double the length of their pedicels; terminal joint with a small projection; verticils small and scattered. Palpi the same colour as the joints of the scapus, as long as the antennæ up to the first joint of the scapus. Thorax ferruginous, with two converging light lines; perfectly glabrous. Scutellum ferruginous, without hairs. Halteres with long slender white pedicels, the clubs being darker owing to the presence of black hairs. Abdomen pink, with long slender ovipositor; very few hairs on the segments. Legs light-brown, long and slender, very slightly hairy. Wings pellucid, glabrous, or slightly hairy. Costa and second longitudinal light-red; first longitudinal a little more than

one-third the length of the wing; second longitudinal strongly arcuated, joining the margin some distance beyond the apex; third longitudinal very slightly bent upwards at the fork.

I obtained two specimens of this insect in a swamp at Wanganui.

*Diplosis flava*, n. sp. Male. Antennæ, 0·092; wings, 0·115 × 0·037; body, 0·059 × 0·013. Joints of the scapus subglobose, bright-yellow; flagellum cinereous; double joints rather shorter than their pedicels, single joint about a quarter the length of their pedicels; length of double joints near the base about three times their breadth, near the apex the length is about double the breadth; terminal joint longer than the three or four double joints immediately preceding it, becoming at its apex a colourless projection closely resembling a broken-off piece of pedicel. Palpi long and slender, light-yellow. Thorax yellow, perfectly glabrous, rather darker on the lateral margins. Halteres with very long and slender pedicels, bearing a small pyriform yellow club. Scutellum white, perfectly glabrous. Abdomen pink, with several bristly yellow hairs on the margins of the segments. Legs long and slender, yellow, but rather thickly clothed with small black hairs. Wings almost glabrous, hyaline. Veins colourless, except the basal portion of the costa, which is yellow; first longitudinal less than half the length of the wing; second longitudinal strongly arcuated, joining the margin some distance beyond the apex of the wing; transverse vein half-way along the first longitudinal; fork of third longitudinal beyond the end of the first longitudinal.

I obtained a single specimen of this insect in a swamp at Wanganui.

*Subsection B.*

Cross-vein very oblique, originating at the root of the first longitudinal vein.

Sub-genus *Epidosis.*—Second longitudinal vein sinuous before the cross-vein. Joints of the antennæ pedicelled in both sexes, their number variable.

*Epidosis magna*, n. sp. (Plate V., fig. 4.) Male. Length of antennæ, 0·188; expanse of wings, 0·153 × 0·055; length of body, 0·068. Antennæ 2 + 22 jointed, longer than body, pale-brown; long pedicels; joints about half the length of the pedicels, sub-globose; verticils long, arranged in two whorls on the joints; scapus joints near base of the flagellum almost cylindrical; joints longest in centre, decreasing in size towards apex. Palpi moderately long. Basal three joints of the flagellum covered with scattered black hairs. Thorax deep-brown, with two tufts of long black hairs, one tuft at each side; collare glistening-white; centre of thorax marked by a cuneiform stripe

of fuscous brown, down the middle of which there is a narrow black line; sides of the fuscous-brown stripe marked by a single row of long black hairs. Scutellum glistening-white, with long black hairs on posterior portion. Halteres long, densely haired; club moderate. Abdomen light yellowish-red, densely covered with long grey or black hairs. Legs long and slender, everywhere covered with short black hairs, which are more numerous on the fore femora and less numerous on the tarsal joints than elsewhere. Wings pellucid, densely pubescent; violet, red, and blue reflections. Costal veins testaceous, but becoming red towards the apex of the wing; cross-veins pale, nearly straight, diverging from first longitudinal about four times the length of cross-vein from end of first longitudinal; second longitudinal thin, with a deep bow before cross-veins, reaches wing-margin beyond the apex; both branches of the third longitudinal indistinct.

Female. Size of body, 0·121; ovipositor, 0·044; antennæ, 0·146; wings, 0·153. Joints of antennæ, 2 + 25; pedicels short; joints cylindrical near base, but becoming orbicular at the apex; last joint two and a half times length of previous joint, subconical. Thorax darker than in the male, cuneiform stripe separated into two narrow linear fuscous-brown stripes approaching one another, and becoming lost opposite the base of the wings. Abdomen darker than in male, but otherwise similar. Ovipositor long, needle-shaped, same colour as abdomen. Verticils not so long as in male.

*Epidosis agricolæ*, n. sp. Female. Antennæ, 0·052; body, 0·090 × 0·011; wings, 0·119 × 0·011. Antennæ longer than the head and thorax, 2 + 11 joints; joints nearly cylindrical, with short pedicels; pedicels of lower joints shortest, those of central joints largest; joints gradually decreasing in size from below upwards; verticils few and scattered. Palpi bright-red, with a few scattered black hairs. Collare testaceous. Thorax a uniform pink colour, with two shallow and narrow grooves extending from the collare, where they are widely separated, to the base of the wings, where they are close together; a few scattered black hairs on the grooves and sides of the thorax. Scutellum rather brighter in colour than the thorax, with a few hairs on the posterior border. Halteres long, with white glabrous pedicels; club white and glabrous. Abdomen of a lighter pink than the thorax, with a few scattered hairs on the segments. Legs long and slender, covered rather thickly with short black hairs. Wings pellucid, thinly covered with black hairs. Second longitudinal vein bent in a short arcuation before junction with cross-vein, afterwards strongly bowed, and terminating beyond the apex of the wing; both

branches of third longitudinal vein indistinct; costal and second longitudinal veins red; transverse vein short, joining first longitudinal three times its own length from end of first longitudinal.

Lincoln, November.

*Epidosis ordinaria*, n. sp. Male. Antennæ, 0·046; body, 0·049 × 0·008; wings, 0·109 × 0·036. Antennæ 2 + 11 joints; joints of scapus nearly white; lowest joints of flagellum nearly cylindrical, shortly pedicelled; pedicels of middle joints longer, and joints shorter and oval; terminal joints small and oval; verticils few but long. Palpi moderately long, testaceous. Thorax dark-brown, becoming lighter posteriorly, with a few scattered black hairs. Scutellum opaque, white, with one or two black hairs, sometimes bordered with red. Halteres fuscous, pedicel densely covered with short black hairs; club moderate, covered with short black hairs. Abdomen pink, with scattered grey hairs. Legs long and slender, clothed with black hairs. Wings pellucid, densely covered with brown hairs, which are especially long in the fringe on the inner margin. Veins testaceous to red; second longitudinal slightly arcuated before junction with transverse veins, afterwards broadly arcuated, and ending slightly beyond apex of the wing; transverse vein short, about a quarter length of first longitudinal from rising-point of transverse to costa.

Most noticeable points: Colour of the scutellum and halteres, and veins of the wing. Common, October to March. Lincoln.

*Epidosis aurea*, n. sp. (Plate VI., fig. 3.) Antennæ broken; wings, 0·110 × 0·048; body, 0·051 × 0·024. Antennæ unfortunately broken in my single specimen; joints of scapus red in colour, with a few black hairs; flagellar joints all oval, with pedicels about half as long as themselves; joints cinereous in colour, with few but long verticils of a black colour. Palpi testaceous. There are eight flagellar joints remaining on one antenna, all of which are similar in size and shape. Anterior portion sides and posterior portion of the thorax orange-yellow in colour, a central dark-brown mark extending from the collare to a little anterior to the point of insertion of the wings, its length being about three times its breadth; on each side one black mark about the same size as the central brown mark, but situated more posteriorly; between the central and lateral marks orange-yellow stripes with a few golden hairs. Scutellum golden-yellow, with a few golden hairs. Halteres light-orange; pedicels long, and, like the club, clothed sparingly with black hairs. Abdomen dark-red, with a few grey hairs scattered over the segments. Legs long and slender, fuscous,

covered with short grey and black hairs. Wings covered all over with short black hairs. Veins brown, distinct; second longitudinal vein nearly straight before junction with cross-vein, afterwards arcuated; transverse cross-vein about one-sixth length of first longitudinal from point of origin of transverse vein to junction with costa.

I have at present only a single specimen of this distinct species, which was captured at the foot of Mount Torlesse early in March.

*Section II.*

Wings with four longitudinal veins.

Sub-family II. LESTREMINA.

Wings with at least four longitudinal veins, or at most five; sometimes a rudimentary vein behind the fifth. The additional vein is placed between the two veins corresponding to the second and third of the first sub-family, and is generally furcate. Ocelli nearly always present. First tarsal joint not shortened.

I. *Ocelli extant.*

A. Wings with four longitudinal veins; the third not furcate; the fourth furcate, representing the fourth and fifth longitudinal veins of other genera coalescent for the first half of their course.

Genus I. CAMPYLOMYZA, Meigen. (Plate VII., fig. 1.)

Antennæ 2+6 to 2+23 jointed, moniliform, verticillate; joints ovate, lentiform, or cylindrical, with long pedicels in the male and sessile in the female, or sessile in both sexes. Wings large, considerably rounded at the apex; in some cases the base of the wing is cuneiform, in other cases the posterior angle is prominently rounded; hairs often scaly; long cross-vein.

A. *Wings cuneiformly narrowed at the base.*

*Campylomyza tenuis*, n. sp. Body, 0·038 × 0·013; antennæ, 0·027; wings, 0·049 × 0·025.

Antennæ grey, 2 + 9 joints; basal joints of flagellum rather large, globose, not quite so long as their pedicels; gradually decreasing in size towards the apex; ornamented with long verticils directed forward and just reaching a little beyond the base of the succeeding joint. Thorax short and broad, black or dark-brown, but paler on the lateral margins; a few long black hairs arise from its surface. Scutellum large, semicircular, grey. Halteres white, with very elongated pyriform clubs, on which some black hairs are situated. Abdomen pale, testaceous, with black hairs scattered over its

surface. Genital appendages elongated. Legs slightly paler than the abdomen; femur rather stout, shorter than tibia; very few hairs on any of the joints. Wings slightly smoky. First longitudinal rather distant from the costa, about half as long as the wing; second longitudinal ends slightly beyond the apex of the wing; basal portion more than five times the length of the transverse vein; third longitudinal very pale, issuing from the basal portion of second longitudinal at a little beyond half its length, disappearing before the margin; fourth longitudinal with a long anterior branch, nearly straight, posterior branch distinct, and strongly arcuated. Surface of wing covered with black hairs.

Lincoln, November.

*Campylomyza lincolniensis.* Male. Antennæ, 0·048; wings, 0·044 × 0·025; body, 0·027 × 0·006.

Antennæ brown; joints of scapus slightly compressed; joints of flagellum thirteen in number, large, globose, decreasing in size from below upwards; pedicels nearly twice as long as the joints; verticils black, long, pointing forwards, just reaching the base of the succeeding joint; terminal joint much smaller than the rest, oval, rather longer than its pedicel, its verticils slender. Thorax about as broad as long, black, but ornamented with a few golden-yellow hairs. Scutellum semicircular, black. Halteres with slender pedicels and a circular white club. Abdomen black, slightly haired. Legs light-brown, rather short and robust, not hairy. Femora rather longer than the tibiæ. Wings pellucid. First longitudinal joins the costa at about half its length, part beyond the transverse vein about twice its length; second longitudinal bent at junction of third longitudinal and of transverse vein, afterwards strongly arcuated, joining margin beyond the apex; basal part about five times the length of transverse vein; third longitudinal arising at about two-thirds of its length; third longitudinal very faint, disappearing before reaching the margin; fourth longitudinal faint, anterior branch nearly straight. Surface of wings covered sparingly with black hairs.

Lincoln, November. Only two specimens.

*Campylomysa minuta,* n. sp. Female. Antennæ, 0·011; wings, 0·035 × 0·014; body, 0·028 × 0·005.

Antennæ dark-brown, 2 + 7 jointed; joints of flagellum with very short pedicels, broader than long, ornamented rather sparingly with long radiating verticils; terminal joint oval, rather longer than the others, and ornamented in the same manner. Thorax dark-brown, with lateral margins much lighter. Halteres with slender white pedicels and a small white club. Abdomen smoky-brown, darker at the posterior

border of the segments. Legs short, the same colour as the abdomen, rather hairy. Wings hyaline. First longitudinal about half as long as the wing, part beyond the transverse vein about as long as the transverse vein; second longitudinal vein distinct, only slightly bent, joining the margin distinctly before the apex of the wing; third longitudinal very indistinct, disappearing long before the margin is reached; fourth longitudinal indistinct, anterior branch long and nearly straight. Surface of the wings covered with a few scattered black hairs.

I have only one specimen, taken at Lincoln in February.

*Campylomzya nitida*, n. sp. Female. Antennæ, 0·028; wings, 0·038 × 0·018; body, 0·033 × 0 008.

Antennæ dark-brown; joints of flagellum thirteen in number, oval, about twice the length of their pedicels, ornamented with a few straight radiating verticils; terminal joint smaller than the others, without any projection. Thorax black and shining, without any hairs. Scutellum light-brown, oval. Halteres with a moderate pedicel and a small white club. Abdomen cinereous, narrowing considerably posteriorly, surface with a few scattered hairs. Legs light-brown; femora and tibiæ robust, with a few scattered black hairs; first joint of tarsus double the length of the second; the others are always slightly shorter than the preceding joint, except the last, which is longer than the fourth. Wings slightly smoky. First longitudinal less than half the length of the costa; transverse vein long, but slightly shorter than that part of the first longitudinal beyond the point of junction; second longitudinal very distinct, distant from first longitudinal, joining margin at the apex; third longitudinal very indistinct, disappearing long before the margin; fourth longitudinal fairly distinct, but both branches disappear before they reach the margin. Surface of the wing with scattered black hairs.

Lincoln, February.

*Campylomyza hirta*, n. sp. Wings, 0·044 × 0·019; body, 0·038 × 0·006.

Antennæ apparently 2 + 11 joints; joints of flagellum dark-brown, almost sessile, ornamented with a few short verticils; terminal joint equal to the others in size. Thorax dark-brown, almost smooth. Scutellum dark-brown. Halteres with a large club, almost black from the clothing of short hairs. Abdomen nearly cylindrical, but bulging out at the segments; dark-brown, but lighter than the thorax and scutellum. Legs short, dull light-yellow, ornamented with rather long black hairs; all the joints are rather stout. Wings hyaline, surface covered with long black hairs. First

longitudinal vein about half the length of the costa, part beyond junction with transverse vein slightly longer than transverse vein; basal portion of the second longitudinal about four times as long as the transverse vein, only slightly arcuated, joining the margin before the apex of the wing; third longitudinal very indistinct, proceeding from the second longitudinal about two-thirds of the length of second longitudinal; fourth longitudinal very indistinct, anterior branch rather long and only slightly bent.

I have only one specimen, and its antennæ are so contorted as to render it almost impossible to count the joints or measure their length. Lincoln, February.

*Campylomyza squamata*, n. sp. Female. Antennæ, 0·037; wings, 0·057 × 0·025; body, 0·042 × 0·011.

Antennæ light-brown, 2 + 10 jointed; joints of scapus lentiform, not hairy; joints of flagellum nearly globose, about half as long as their pedicels, last two joints much smaller than the rest, and with much shorter pedicels; terminal joint oval; all flagellar joints ornamented with long verticils directed forward and reaching to about the middle of the succeeding joint. Thorax black, almost destitute of hairs. Scutellum dark-brown. Halteres with short pedicels and small club. Abdomen black, covered with black hairs; genitalia orange. Legs light dull-yellow, the posterior pair being much longer than the two anterior pairs; femora and tibiæ robust, covered with short black scaly hairs, very loosely attached. Wings pellucid. Veins light-brown, rather inconspicuous owing to the thick covering of scaly black hairs spread over the surface of the membrane; first longitudinal slightly more than half the length of the wing; transverse vein situated rather more than its own length from the end of the first longitudinal; second longitudinal ending at the apex; third longitudinal arising about two-thirds of the length of the basal portion of second longitudinal, disappears long before reaching the margin; anterior branch of fourth longitudinal distinct, arcuated, reaching the margin; posterior branch only slightly bent, does not reach the margin.

I have only one specimen, taken at Lincoln in September.

B. *Wings rounded at the base.*

*Campylomyza magna*, n. sp. Female. Antennæ, 0·017; wings, 0·088 × 0·039; body, 0·083 × 0·016.

Antennæ dark-brown, 2 + 10 jointed, nearly cylindrical; joints of scapus only slightly hairy; flagellar joints sessile, covered with a short pubescence; terminal joint the smallest. Palpi short and stout, brown. Thorax black, a central wedge-shaped portion shining, but the rest dull. Halteres with a

short brown pedicel, but a large cinereous club. Abdomen cylindrical, terminating in a short ovipositor. Abdomen clothed with short black hairs. Legs short and rather robust, dark-brown; first joint of the tarsus about half as long as the tibia and about double the length of the second joint; very few hairs on any of the joints. Wings smoky. Second longitudinal and costa dark-brown, the others lighter; distinct indication of auxiliary vein, but it does not join the costa; first longitudinal rather more than half the length of the wing, bending down at the junction of the transverse vein, which is only one-fifth of the length of remaining portion of first longitudinal; basal portion of second longitudinal about one-third of the length of vein, only slightly bent, joins margin before the apex of the wing; third longitudinal very indistinct, arising from second longitudinal at a little beyond a third of length of basal portion, cannot be followed more than a third of the distance to the margin; fourth longitudinal distinct, anterior branch only slightly bent, posterior branch almost at right angles, disappears before reaching the posterior margin of the wing. Posterior angle of the wing pronounced. Surface covered with a minute brown pubescence.

I have only one specimen of this large distinct species, taken at Lincoln in December, 1893.

*Campylomyza robusta*, n. sp. Male. Antennæ, 0·024; wings, 0·070 × 0·031; body, 0·055 × 0·011.

Antennæ black, 2 + 11 jointed; flagellar joints almost globose; pedicels about a quarter the length of the joints; all the joints are covered with hairs, but there are no verticils; subterminal joint oval, and longer than the others, which are slightly compressed longitudinally; terminal joint much smaller than the others, apparently without a pedicel. Thorax black, clothed sparingly with light-coloured hairs. Scutellum black. Halteres with short thick brown pedicels, ending in rather a large oval cinereous club. Abdomen very dark brown, covered with scattered black hairs. Legs light-brown; femora about the same length as the tibiæ, thick, clothed sparingly with light-coloured hairs. Wings with a distinct anal angle, rather smoky, covered with black hairs. First longitudinal less than half the length of the wing, part beyond point of origin of transverse vein about four times the length of transverse vein; second longitudinal slightly bent, ending a very little before apex of the wing, very distinct; third longitudinal very indistinct, arising a little beyond middle point of basal portion of second longitudinal; both branches of fourth longitudinal distinct, but the posterior branch does not reach the margin.

Lincoln, February.

*Campylomyza ordinaria*, n. sp. (Plate V., fig. 5.) Male and female. Antennæ, 0·012; wings, 0·063 × 0·029; body, 0·052 × 0·007.

Antennæ light-brown, 2 + 10 joints; first joint of scapus large, globose, second much smaller; lowest joint of flagellum lighter than the rest, oval, others subglobose, with pedicels about half their length; ornamented with numerous verticils about twice as long as the diameter of the joints; terminal joint oval, much smaller than the rest. Thorax dark-brown, with a few hairs. Scutellum semicircular, brown. Halteres with a short pedicel bearing an elongated pyriform club, light-brown in colour, and pubescent. Abdomen dark-brown, ornamented with numerous brown hairs. Legs more elongated than usual; femora and tibiæ robust; very light brown or pale-yellow, thinly clothed with rather long light-coloured hairs. Wings rather smoky, clothed with rather a thick covering of light-brown hairs. Slight rudiment of auxiliary vein; first longitudinal less than half the length of the wing, part beyond point of origin of transverse vein about twice the length of the transverse vein; second longitudinal slightly curved, ending at the apex of the wing. Third longitudinal indistinct, disappearing a little distance from the margin; fourth longitudinal indistinct, anterior branch nearly straight, reaching the margin, posterior branch nearly at right angles to it, and disappearing close to the margin.

Two specimens, one male and one female. Lincoln, February.

Genus LESTREMIA, Macquart.

Antennæ moniliform, verticillate, in the male 2 + 14, in the female 2 + 9 to 2 + 10 jointed; the joints in the male almost ovate, pedicelled; in the female more cylindrical, with short pedicels. Wings large, moderately broad, with prominent posterior angle. First longitudinal vein very short; second longitudinal short, running rather close to costa, joining the border much before the apex of the wing; third longitudinal vein with a very long fork; cross-vein small beyond the middle of the first longitudinal vein.

Skuse records no species from Australia, but says the genus is represented by a few American and European species.

There seems to be some doubt as to whether ocelli are present in the European species. As shown in Plate VI., fig. 4, three ocelli are always present in the New Zealand species.

*Lestremia novæ-zealandiæ*, n. sp. (Plate VI., fig. 1.) Female. Antennæ, 0·033 (largest), 0·014 (smallest); wing, 0·126 × 0·050 (largest), 0·071 × 0·028 (smallest); body, 0·122 × 0·022 (largest), 0·060 × 0·014 (smallest).

Antennæ dark-brown; joints cylindrical, with very short pedicels; terminal about half as long again as the penultimate joint; a circlet of short verticils arises from the basal portion of each joint. Lower portion of frons black. Three ocelli, situated in a triangle just above point of insertion of the antennæ. Compound eyes far apart, emarginate, the antennæ being situated in the bend in the outline. The antennæ are nearly surrounded by a single row of facets, bead-like in appearance. Palpi light-yellow. Thorax dark-brown, hood-shaped; two stripes of lighter colour inclined to one another like the sides of a wedge, the point directed posteriorly; on these stripes long hairs are situated. Scutellum dark-brown, with a row of hairs along posterior margin. Halteres with short pedicels ending in elongate pyriform clubs; light-brown in colour, with scattered black hairs. Abdomen dark-brown, anterior portion of third and succeeding segments light-brown. Surface of all the segments with slender light-coloured hairs. Legs not much longer than the abdomen; light-brown femora, rather shorter than tibiæ; latter light-pink at the tip; first joint of tarsus more than double the length of the second, others all shorter than the one preceding them. Wings pellucid, covered with scattered short black hairs. Costal and second longitudinal pink; rudiment of auxiliary vein present; first longitudinal more than one-third the length of the wing, cross-vein near its tip very oblique; second longitudinal ending long before the tip of the wing; third longitudinal branching out of second just before junction with cross-vein, fork long, both branches wavy, anterior branch ends at the tip of the wing; fourth longitudinal commencing nearer base of wing than third longitudinal, nearly straight, almost disappears before reaching the margin; fifth longitudinal distinct, strongly arcuated; sixth longitudinal short, lying close alongside fifth longitudinal. Posterior angle of the wing very distinct.

Lincoln. Fairly common, especially in very early spring, but is found all the year round.

Male. Antennæ, 0·055 (largest), 0·035 (smallest); wing, 0·077 × 0·030 (largest), 0·060 × 0·024 (smallest); body, 0·052 × 0·011 (largest), 0·046 × 0·011 (smallest). (Plate VI., fig. 2.)

Antennæ light-brown, 2 + 14 joints; joints cylindrical, with pedicels twice their length; all the joints appear double; ornamented with rather long verticils arising from the constriction in the middle of the joint; terminal joint oval, larger than those immediately preceding.

At first I thought that there were three distinct species, which, on examination, proved to differ only in size. This,

however, is very marked, though not constant enough to constitute distinct species. In all other particulars but size all my specimens are exactly identical; the antennæ, veins of the wings, and other organs show no variation. I have not been able to examine the palpi in any but a very few specimens, but, so far as I have been able to ascertain, the structure is constant.

All measurements given above are in inches.

## EXPLANATION OF PLATES.

### PLATE V.

Fig. 1. *Miastor agricolæ*, female.
Fig. 2. *Cecidomyia destructor*, male. The only object of this diagram is to illustrate the difference between this genus and *Diplosis*.
Fig. 3. *Diplosis dubia*, female.
Fig. 4. *Epidosis magna*, male.
Fig. 5. *Campylomyza ordinaria*, female.

These figures were all drawn from dried specimens. Their chief object is to illustrate the difference between the various genera to which they belong. They should not be relied on for specific characters.

### PLATE VI.

Fig. 1. *Lestremia novæ-zealandiæ*, female.
Fig. 2. " " male.
Fig. 3. Side view of *Epidosis aurea* (antennæ broken).
Fig. 4. Head of *Lestremia novæ-zealandiæ: o*, occiput; *e*, compound eye; *f*, frons; *g*, ocelli; *a*, antennæ; *p*, palpi.

### PLATE VII.

Fig. 1. Portion of antenna of *Campylomyza*.
Fig. 2. Portion of antenna of male of *Diplosis wanganuiensis*.
Fig. 3. Male of *Diplosis fragilis*.
Fig. 4. Diagram of ideal dipterous wing.

*Cells.*

A. First costal cell.
B. Second costal cell.
C. Third costal cell.
D. Marginal cell.
E. Submarginal cell.
F. First posterior cell.
G. Second posterior cell.
H. Third posterior cell.
I. Discal cell.
K. First or large basal cell.
L. Second basal cell, or anterior of the small basal cells.
M. Third basal cell, or posterior of the small basal cells.
N. Anal or axillary corner of the wing.
O. Alar appendage (alula).

*Veins.*

*a*. Transverse shoulder-vein.
*b*. Auxiliary vein.
*c*. First longitudinal vein.

*d.* Second longitudinal vein.
*e.* Third longitudinal vein.
*f.* Fourth longitudinal vein.
*g.* Fifth longitudinal vein.
*h.* Sixth longitudinal vein.
*i.* Small or middle transverse vein.
*k.* Hinder transverse vein.
*l, m, n, o.* Costal veins.
*p.* Anterior basal transverse vein.
*q.* Posterior basal transverse vein.
*r.* Rudiment of a fourth trunk.
*s.* Axillary incision.
*t.* Anterior branch of third longitudinal.
*u.* Anterior intercalary vein.
*v.* Posterior intercalary vein.

## Art. XXV.—*New Zealand Diptera: No. 2.*—Mycetophilidæ.

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[*Read before the Philosophical Institute of Canterbury, 5th June, 1895.*]

Plates VIII.-XIII.

In common with the other families of smaller flies, the *Mycetophilidæ* have suffered sadly from neglect at the hands of New Zealand entomologists. The only species hitherto recorded as existing in this colony were described by Captain Hutton in the "Catalogue of the New Zealand Diptera." He there gives descriptions of two species, one of which he places in the genus *Mycetophila*, and the other in the genus *Platyura*. The specimens from which Captain Hutton drew his descriptions are fortunately still extant in the museum of Lincoln Agricultural College, so I have been able to examine them; but I am unable to agree with Captain Hutton as to the place he assigns them in the classification of the *Mycetophilidæ*. For reasons that will be given later on, I have deemed it necessary to establish new genera for both these flies, as they possess characters that certainly will not allow them to be placed in any previously-described genera. So far as my observations on the New Zealand representatives of this family have gone, I have been struck with the great diversity of type and structure that is exhibited by our species, for out of seven sub-sections into which the family is divided six are

abundantly represented in this colony. This is the more remarkable when one considers that all the Australian forms hitherto described are included in four of these sub-sections. In the majority of these divisions there are insects that differ radically from any previously-established genera, and for these new genera have been established, though with considerable reluctance in one or two cases. The insects of this family can easily be distinguished from all others by their strongly-curved thorax, and legs armed with strong spurs, as well as by the arrangement of the veins of the wings. They can be taken very commonly on windows facing shady gardens at almost any time throughout the year. They are abundant in the early spring, and at Lincoln a few stragglers will be found as late as the middle of June. At Wanganui no less than ten distinct species could be found as late as the middle of July, and would doubtless be as numerous right through the winter. In their native haunts they can be taken abundantly by sweeping the undergrowth and ferns in all damp bush throughout the summer and the greater part of winter. Though usually small insects, one of our native species is more than an inch in expanse of wings, and to a casual observer would appear to belong to the *Tipulidæ* rather than to the *Mycetophilidæ*.

In the present paper I give descriptions of thirty-five species, of which the majority belong to old-established genera. They are distributed as follows: *Macrocera*, 4 species; *Bolitophila*, 1; *Ceroplatus*, 3; *Platyura*, 4; *Sciophila*, 1; *Tetragoneura*, 1; *Brachydicrania*, 1; *Aphelomera*, 1; *Mycetophila*, 6. Of these genera, species of *Macrocera*, *Ceroplatus*, *Platyura*, *Sciophila*, and *Mycetophila* have been described from Australia and the Old World. Species of *Bolitophila* and *Tetragoneura* have been described from the Old World, but not from Australia; while the genera *Heteropterna* and *Brachydicrania* have been established for insects recently described from Australia. Of the new genera established in this paper, the first three belong to the sub-section *Mycetobinæ*, in which there were but three previously-existing genera, containing but few species, all of which have been described from the Old World, Australia, so far, not having been shown to possess any. Two of the new genera are in some respects highly peculiar, and without doubt form a very interesting feature of the New Zealand Diptera. The other new genera belong to well-represented sub-sections, and have many characteristics in common with previously-described genera, but, owing to the rigid manner in which the genera of this family are described, and the slight variations that are considered sufficient to justify their separation, they cannot be placed in any of the old genera. Some of the genera here

described may very possibly be discarded subsequently, when our insects have been further investigated. Many that are here described as species may afterwards be reduced to varieties, while some of my varieties may very probably be raised to the rank of species. But, though blunders have been made, none of the genera and species described in this paper have been separated from others without considerable thought and care where the issue seemed in any way doubtful.

## Classification.

Winnertz, the great authority on this family of flies, divided it into a large number of genera, separated from one another by what at first sight appear to be comparatively insignificant characteristics. His classification has been adopted by all subsequent workers at the family, and has always been found thoroughly satisfactory. Although it may seem in some ways unnecessary to establish so many genera, yet if some were eliminated the remainder would contain such an enormous number of species that it would be necessary to establish subgenera and other minor divisions in order to provide for their thorough, systematic classification. The family is divided by Winnertz into three sections, according to the characters of the alar venation. All of these sections are numerously represented in New Zealand. The last sub-section of all, *Mycetophilinæ*, is divided into three classes, according to the number and position of the ocelli. It is this division that seems to me somewhat unsatisfactory so far as some of our New Zealand species are concerned. In one genus, for instance, which I have called *Anomala*, there are two species evidently closely allied, but differing in size, coloration, and other specific characters; in addition to merely specific distinction, however, the larger species has only two ocelli, and the other undoubtedly has three, and on account of this difference would, if Winnertz' classification were strictly adhered to, have to be placed not only in distinct genera, but even in different classes. As the two species are evidently so closely allied I have included them both in the same genus, and hope subsequently to come across other species showing a transition, and therefore justifying my classification. The first section is divided into five sub-sections, of which all but the first have New Zealand representatives. The second sub-section, *Mycetobinæ*, as far as I can ascertain, embraces but a few species, which are placed in three genera. I already possess four distinct and in some respects peculiar species belonging to this sub-section, and have found it necessary to establish three new genera for their reception. From the comparatively limited area over which I have searched compared to the vast extent of forest-land in this country, I feel confident that

many more species, and probably genera, will yet be discovered belonging to the sub-section *Mycetobinæ*. Generally the *Mycetophilidæ* are excessively abundant in the colony, owing probably to the great extent of damp bush-covered country, and wherever search is made new species are discovered in comparative plenty.

The following is a *résumé*, taken from Skuse's "Monograph of Australian *Mycetophilidæ*," of Winnertz' classification of the family. Only those genera are described that have so far been shown to possess representatives in this colony. Where genera of my own are mentioned their probable relation to other genera is indicated.

Section I.—Second longitudinal vein arising from the fourth longitudinal vein, at the middle of it, or more or less before the middle of it. Marginal cross-vein elongated, very obliquely situated. Inner marginal cell dilated. Anterior branch of the second longitudinal vein seldom missing (in *Diadocidia* only). Anterior branch of the fourth longitudinal vein issuing from the base of the second longitudinal vein. Fifth longitudinal vein generally perfect. Ocelli on the front.

Section II.—Second longitudinal vein arising from the fourth longitudinal vein near the root of the wing. Marginal cross-vein not elongated. Inner marginal cell not dilated. Anterior branch of the second longitudinal vein always present, very small, situated very near the marginal cross-vein; consequently the marginal cell is very short. Anterior branch of the fourth longitudinal vein issuing from the fourth longitudinal vein beyond, at, or before the middle of it. Fifth longitudinal vein incomplete. Three ocelli on the front.

Section III.—Second longitudinal vein, marginal cross-vein, fifth longitudinal vein, and inner marginal cell as in the last section. Anterior branch of second longitudinal vein always missing; therefore only two submarginal cells. Anterior branch of the fourth longitudinal vein arising from the fourth longitudinal vein beyond, at, or before the middle of it, rarely missing, more rarely still the anterior branch of the third longitudinal vein missing. Ocelli three, or only two—namely: (A) Three on the front; (B) three, one on the inner margin of each of the compound eyes, the third always very small, situated in the middle of the anterior margin of the front; (C) two, one on the inner margin of each of the compound eyes.

## *Summary of the Genera at present known in New Zealand.*

### SECTION I.

#### Sub-section I. Diadocidinæ.

#### Sub-section II. Mycetobinæ.

Anterior branch of the second longitudinal vein large, ending in the costa, and forming with the second longitudinal a fork having its base at or beyond the marginal cross-vein. Anterior branch of the fourth longitudinal vein and the third longitudinal vein issuing from the second longitudinal vein. Fifth longitudinal vein perfect. Inner marginal cell large. Surface of the wing hairy, or only microscopically pubescent.

Genus *Nervijuncta*, gen. nov.

Anterior branch of the second longitudinal vein and the second longitudinal vein forming a fork having its base beyond the marginal cross-vein; base of the fork lying just before the base of the third submarginal cell. Surface of the wing hairy. Third longitudinal vein arising from the second longitudinal vein beyond the apex of the inner marginal cell.

This genus is closely allied to *Ditomyia*, but differs from it in the third longitudinal vein arising beyond the apex of the inner marginal cell.

Genus *Cyrtoneura*, gen. nov.

Auxiliary vein long, complete. Anterior branch of second longitudinal very long. Fork formed by branches of second longitudinal with its apex lying behind the apex of the fork of the third longitudinal vein. Both branches of second longitudinal vein highly arcuated. Surface of wings slightly hairy.

This genus is very different from any previously described. It should probably occupy the first place in the sub-section.

Genus *Huttonia*, gen. nov.

Auxiliary vein absent. Fork formed by the branches of the second longitudinal vein, long. Anterior branch of third longitudinal represented by a rudiment extending a short distance into the disc from the posterior margin. Posterior branch of third longitudinal also disconnected, but longer than the anterior branch. Anterior branch of fourth longitudinal also disconnected, but longer than the others.

This genus is also very distinct from any previously described. It should occupy the last place in the sub-section.

#### Sub-section III. Bolitophilinæ.

Genus *Bolitophila*, Meig.

Anterior branch of second longitudinal vein short, lying almost vertically to the costa or to the first longitudinal vein (occasionally absent), and forming with the second longitu-

dinal a fork with a long petiole. From the second longitudinal vein, bent angularly in the vicinity of the root, issue the anterior branch of the fourth longitudinal and the third longitudinal vein. Fifth longitudinal vein perfect. Inner marginal cell large, moderately dilated. Surface of wing microscopically pubescent. Antennæ very long, setiform.

This genus is represented by one species in New Zealand; none have been described from Australia. The New Zealand species has no anterior branch of second longitudinal, and the antennæ are not long.

### Sub-section IV. MACROCERINÆ.

Genus *Macrocera*, Meig.

Anterior branch of second longitudinal vein small (occasionally absent), lying in an oblique position, running into the costa, and forming a fork with a long petiole with the strongly-curved second longitudinal. Anterior branch of the fourth longitudinal vein arising from the second longitudinal vein near the base; the third longitudinal vein arising from the same vein a little anterior to the anterior branch of the fourth longitudinal. Fifth longitudinal vein perfect. Inner marginal cell small, moderately dilated. Surface of the wing microscopically pubescent, rarely more hairy. Antennæ very long, filiform.

This genus is almost cosmopolitan. It is represented by several species in New Zealand and Australia.

### Sub-section V. CEROPLATINÆ.

Anterior branch of second longitudinal vein small, joining the costa or first longitudinal, forming a fork with a long petiole. Anterior branch of the fourth longitudinal vein arising nearer the base of the latter. Fifth longitudinal vein complete or incomplete. Inner marginal cell short, moderately dilated. Surface of the wing microscopically pubescent.

Genus *Ceroplatus*.

Antennæ broadly flattened. Palpi not incurved. Legs long and slender. Auxiliary vein reaching the costa before the origin of the third longitudinal vein.

This genus is represented by several species in New Zealand. In the present paper I describe three.

Genus *Platyura*.

Antennæ not broadly flattened, somewhat compressed, 2 + 14 jointed. Palpi incurved. Auxiliary vein usually united to the first longitudinal by the subcostal cross-vein. Anterior branch of the second longitudinal vein short, ending either in the first longitudinal or in the costal vein. Third submarginal cell with a very short petiole.

## SECTION II.

### Sub-section VI. SCIOPHILINÆ.

Genus *Sciophila*.

Tip of the costal vein uniting with the tip of the second longitudinal vein at the apex of the wing. Base of the second posterior cell nearer to the root of the wing than the base of the third submarginal cell. Auxiliary sometimes complete and terminating in the costa above the marginal cell, and sometimes incomplete. Surface of the wing microscopically pubescent. Intermediate coxæ of the male sometimes with an upward-bent spine.

I have only one species belonging to this genus, and of that I have grave doubts, but I place it here until I can obtain better specimens.

Genus *Parvicellula*, nov. gen.

Costal vein extending considerably beyond the apex of the second longitudinal vein, but not reaching the apex of the wing. Auxiliary vein rather stout, almost one-third the length of the wing. Subcostal cross-vein situated near the apex of the inner marginal cell. Petiole of second longitudinal vein very short. Fourth longitudinal vein unbranched.

I have only one species of this genus. It is rather common at Lincoln towards the end of the summer.

Genus *Tetragoneura*, Winn.

Costal vein extending far beyond the tip of the second longitudinal vein, but not as far as the apex of the wing. Auxiliary vein small, bent posteriorly, ending in the first longitudinal vein far before the marginal cell, or shortened to a tooth. The marginal cell far beyond the middle of the first longitudinal vein. Inner marginal cell much lengthened. Fork of the third longitudinal vein with a moderately long petiole. Base of the second posterior cell lying before the base of the third submarginal cell. Surface of the wing microscopically pubescent.

I have only one species of this genus.

## SECTION III.

### Sub-section VII. MYCETOPHILINÆ.

#### A. *Three ocelli on the front.*

Genus *Aneura*, gen. nov.

Costal vein reaching the apex of the wing. Auxiliary vein more than one-third the length of the wing. Subcostal cross-vein absent. Second longitudinal vein ending in the costa some distance before its apex. Fourth longitudinal vein forked.

I have only one species of this genus. It is distinguished from nearly all the other genera of this sub-section by the absence of the subcostal cross-vein.

Genus *Euryceras*, nov. gen.

Costal vein extending beyond the tip of the second longitudinal vein, but not reaching the apex of the wing. Auxiliary vein ending in the costa at about one-third the length of the wing; subcostal cross-vein situated about half-way along it. Basal portion of the second longitudinal vein and the marginal cross-vein equally long. Inner marginal cell short. Third longitudinal complete. Surface of the wing distinctly hairy. Antennæ compressed.

I have only one species of this genus.

Genus *Anomala*, nov. gen.

Second longitudinal joining costa not far before the apex of the wing. Costa nearly reaching apex of wing. Subcostal cross-vein missing. Inner marginal cell somewhat lengthened, but its apex lies some distance before base of second submarginal cell. Fork of third longitudinal vein short, its petiole rather long. Base of the second posterior cell situated before the origin of third longitudinal vein.

This genus includes two species, both of which are common. It is closely allied to *Leia*, *Ateleia*, and *Cœlosia*.

Genus *Aphelomera*, Sk.

Costal vein extending far beyond the tip of the second longitudinal vein, but stopping before the apex of the wing. Auxiliary vein joining the costa a short distance before the marginal cross-vein; no subcostal cross-vein. Marginal cross-vein situated very much before the middle of the first longitudinal vein. Third longitudinal vein detached from the second longitudinal, starting in the wing-disk beyond the marginal cross-vein; no anterior branch. Anterior branch of the fourth longitudinal vein quite detached, appearing as a short piece of a vein joining the margin. Fifth longitudinal vein very rudimentary. Wing microscopically pubescent. Abdomen with six segments.

I have only one species belonging to this Australian genus.

Genus *Cycloneura*, nov. gen.

Auxiliary vein represented by a rudiment. First longitudinal vein ending at about half the distance along the wing. Second longitudinal vein detached at the base, ending some distance before the apex of the wing, and before the end of the costa. Third longitudinal vein detached at the base, ending a little beyond the apex of the wing; posterior branch missing. Fourth longitudinal vein detached at the base.

Fifth longitudinal vein complete, joined beyond half its length by a vein probably corresponding to the posterior branch of the fourth longitudinal vein.

I have only one species of this genus.

Genus *Paradoxa*, nov. gen.

Auxiliary vein represented by a rudiment. Costa ending some distance before apex of the wing. First longitudinal vein ending in the costa about half-way along the wing. Second longitudinal ending in the costa some distance before its end. Third longitudinal vein with rather short petiole and long fork; posterior branch slightly detached at its base. Fourth longitudinal not forked. Fifth longitudinal as in *Cycloneura*.

I have only one species of this genus.

*B. Three ocelli, one on the inner border of each of the compound eyes, the third one situated in the middle of the anterior border of the front.*

Subcostal cross-vein missing. Surface of the wing microscopically pubescent. Abdomen of the male with six segments.

Genus *Zygomyia*, Winn.

Tips of the costal and second longitudinal veins uniting far before the apex of the wing. Auxiliary vein incomplete, bent anteriorly, gradually disappearing or only forming a tooth. Apex of the inner marginal cell not situated beyond the base of the second submarginal cell. Petiole of the fork of the third longitudinal very short. Anterior branch of the fourth longitudinal vein wanting. Fifth longitudinal vein incomplete. Sixth longitudinal vein in most cases longer.

I have two species belonging to this genus.

*C. Two ocelli, one on the inner border of each of the compound eyes.*

Surface of the wing microscopically pubescent. Costal vein not extending beyond the tip of the second longitudinal vein. Subcostal cross-vein missing.

Genus *Mycetophila*, Meig.

Auxiliary vein incomplete, bent anteriorly. Apex of the inner marginal cell lying over the base of the second submarginal cell. Branches of the fourth longitudinal fork inclined towards one another at their tips. Fork of the third longitudinal vein with a very short petiole, or almost sessile. Base of the second posterior cell before, under, or a little beyond the base of the second submarginal cell. Fifth longitudinal vein incomplete, broken off before the base of the second posterior cell, or disappearing. Abdomen of the male with six segments.

Genus *Brachydicrama*, Sk.

Auxiliary vein incomplete, very short, bent posteriorly. Apex of the inner marginal cell lying over the base of the second submarginal cell Fork of the third longitudinal vein with a very short petiole. Second posterior cell small, its base situated far beyond the base of the second submarginal cell. Branches of the fourth longitudinal fork divergent. Fifth longitudinal incomplete, long, ending just before the base of the second posterior cell. Sixth longitudinal vein longer. Abdomen of the male with six segments.

Genus *Brevicornu*, nov. gen.

This genus is separated from *Mycetophila* by the character of the antennæ.

## CHARACTERS OF THE FAMILY.

The larvæ of the *Mycetophilidæ* are generally cylindrical, attenuated towards both extremities, soft, fleshy, smooth or a little wrinkled, moist, often viscous, more or less translucent, with twelve more or less clearly determinable segments in addition to the head. Stigmata placed—one pair on the first segment of the thoracic region, and one pair on each of the abdominal segments from the first to the seventh inclusive. Head horny. Short mandibles and palpi occasionally present, and also rudimentary antennæ. The larvæ differ very much in appearance and form, not only in the different genera, but also in different species of the same genera.

The only observations that have hitherto been published are some notes by Mr. G. V. Hudson on the larva of *Bolitophila luminosa* (Trans. N.Z. Inst., vol. xxiii., p. 47). This larva is abundant in all damp and dark bush-gullies in many parts of the colony. It lives suspended in a glutinous web, formed of material which is probably secreted by the salivary glands, though it seems to cover the whole surface of the body. It is whitish and transparent, about ¾in. in length, with short rudimentary antennæ. It emits a brilliant phosphorescent light, and hence has obtained the popular name of the "New Zealand glow-worm." I have not been able to ascertain what the larva feeds on, but probably on small mould and other fungi that abound in the localities where the larvæ are found. The only other species whose larvæ are known to me is *Ceroplatus dendyi*. Professor Dendy found numerous specimens under logs in beech-forest on Mount Alford. One of the larvæ that he gave me pupated in due time, and the imago escaped from the pupa-skin in February; one other pupated, but did not hatch. The larvæ are about 1in. or 1¼in. in length; in general shape like those of *Bolitophila luminosa*, but more cylindrical, and marked with rings of ferruginous brown.

I have seen similar larvæ in other localities, but have been unable to keep them. Like *B. luminosa*, the *Ceroplatus* larva forms a glutinous web in crannies of the log under which it lives, and in this web it habitually lives. It seems unable to crawl on any hard surface, but remains suspended in its web, and when it moves it enlarges the web first. These larvæ are not luminous, in this respect differing from the larvæ of *C. mastersi*, Sk. The exact function of the glutinous web I can do no more than guess at. It may, as mentioned above, assist in locomotion; it may enable the suspended larva to keep out of the reach of enemies such as planarian worms or predaceous insects. A diagram of the digestive organs of a Mycetophilid in Theobald's "British Flies" shows extremely large salivary glands, and he remarks that these glands usually extend the whole length of the body; the glutinous material is probably secreted by them. The pupa of both *B. luminosa* and *C. dendyi* is suspended in the web formed by the larva.

About eight hundred species of *Mycetophilidæ* are at present known. Many of the genera appear to be almost cosmopolitan. All the largest genera of Europe are represented in New Zealand. Judging from the very varied types I have already collected, I should think that New Zealand will prove to be far richer in species than Australia, for, though the number of species described by Skuse in all probability represent but a small proportion of the total number, those described are confined to comparatively few of the subsections.

## IMAGO.

### External Structure.

The head is narrower than the thorax, round or oblong or flattened hemispherical on the fore part, situated deep in the thorax. Front of both sexes broad. Eyes round or oval, frequently emarginate on the inner side or reniform, set with short hair. Ocelli three, or only two: in the former case they are either disposed in a triangle, in a bent or sometimes a straight line on the front, or two are situated one on the border of each of the compound eyes, and the third placed in the middle of the anterior border of the front; in the other case, always at the inner border of each of the compound eyes. Proboscis short, retired, rarely elongate or beak-shaped. Palpi three- or four-jointed, prominent, generally incurved, the first joint always very small. Antennæ generally arcuated, straight, or diverging sideways, 2 + 10 to 2 + 15 jointed; the joints of the scapus distinctly set off; flagellar joints pubescent, sometimes verticillate-setose. Thorax ovate, more or less arched. Prothorax with close short pubescence, sometimes with longer hair, perhaps mixed

with setiferous hair. Metathorax highly arched or perpendicular. Scutellum generally small, semicircular, sometimes large, rounded, triangular, generally setiferous; no transverse suture. Abdomen six- or seven-segmented, rarely eight-segmented, cylindrical or compressed at the sides, narrower at the base. Male with a large or small anal joint holding forceps; female with an ovipositor with two terminal lamellæ; the hair, except in a few cases, short and lying close. Legs sometimes long and slender, sometimes short and robust. Coxæ very strong and elongated. Femora broadly flattened, usually strong. Tibiæ spurred, and with lateral spines, rarely without the latter; fore ones with a spur and a very short spine, two hind ones with two spurs and one to four ranges of lateral spines on the outside, and generally with one range on the inner side; rarely all the tibiæ unarmed. Tarsi long and slender, or short and strong; metatarsus frequently prickly. Wings ovate, longer or shorter than the abdomen, with a broad, rounded, more or less cuneiform base. Five or six longitudinal veins, the fifth generally, the sixth always, rudimentary; three cross-veins, of which the humeral and submarginal are always present. Third and fourth longitudinal veins almost always, and the second longitudinal sometimes, forked. No discoidal cell. The first and fourth longitudinal veins are always complete, and form the most important veins issuing from the root of the wing. The costal vein either extends quite to the apex of the wing or stops rather short. The auxiliary vein is often incomplete. Second longitudinal vein issues from the fourth longitudinal vein near its middle or close to its base—in the former case it is broken in an angle, in the latter case it arises obliquely; it joins the costa at or before the apex of the wing. The anterior branch of the fourth longitudinal vein issues rarely near the root of the second longitudinal vein. When the second longitudinal vein issues from the middle of the fourth longitudinal vein it is at the base coalescent with the anterior branch of the fourth longitudinal vein, and the third longitudinal vein has its origin a little below or above the marginal cross-vein, and its fork lies higher up in the wing-disc. In this arrangement the second longitudinal vein is rarely simple, but usually sends out an anterior branch, which runs into the costa or into the first longitudinal vein; this branch may be short or long. When the second longitudinal vein issues from the base of the first longitudinal vein the third longitudinal vein issues from the angle before the marginal cross-vein. Rarely the anterior branch of the fourth longitudinal vein is missing, still more rarely the anterior branch of the third longitudinal vein; infrequently one of these branches is or both are detached at the base. Fifth longi-

tudinal generally only rudimentary. Between the fourth and fifth longitudinals there is generally a longitudinal fold appearing like a vein under and close to the fourth longitudinal vein. Sixth longitudinal vein rudimentary or entirely missing.

When the marginal cell is divided by an anterior branch of the second longitudinal vein the cell thus formed is regarded as the first submarginal cell; otherwise the cell between the second and third longitudinals is the first submarginal cell. In some genera the cells are reduced to one submarginal and one posterior cell.

## SUMMARY OF GENERA DESCRIBED IN THIS PAPER.

Sub-section MYCETOBINÆ.

*Cyrtoneura*, gen. nov.
*Nervijuncta*, gen. nov.
*Huttonia*, gen. nov.

Sub-section BOLITOPHILINÆ.

*Bolitophila*, Europe and America.

Sub-section MACROCERINÆ.

*Macrocera*, Europe, America, and Australia.

Sub-section CEROPLATINÆ.

*Ceroplatus*, Europe, America, and Australia.
*Platyura*, Europe, America, and Australia.

Sub-section SCIOPHILINÆ.

*Sciophila*, Europe, America, and Australia.
*Parvicellula*, gen. nov.
*Tetragoneura*, Europe and America.

Sub-section MYCETOPHILINÆ.

*Aneura*, gen. nov.
*Euryceras*, gen. nov.
*Anomala*, gen. nov.
*Paradoxa*, gen. nov.
*Cycloneura*, gen. nov.
*Aphelomera*, Australia.
*Zygomyia*, Europe.
*Brachydicrania*, Australia.
*Mycetophila*, Australia, Europe, and America.
*Brevicornu*, gen. nov.

### CYRTONEURA, gen. nov.

Head oblong, broader than long, front not flattened. Eyes large, oval, emarginate, meeting above the antennæ. Ocelli three, large, the central one being situated in front of the

others. Epistome setose. Proboscis prominent, rather longer than the palpi. Palpi four-jointed; first joint short, about as broad as it is long; second joint long and greatly swollen, broadest in the middle; third joint rather shorter, cylindrical, much narrower than the first two joints; fourth joint slender, cylindrical, longer than any of the others. Antennæ shorter than the thorax, 2 + 15 jointed; first joint of scapus cupuliform, twice as long and twice as broad as the second, which is also cupuliform; joints of flagellum cylindrical, length about three times the breadth, covered with a dense pubescence, central portion of each joint with stout setæ. Thorax strongly arched, its surface covered with a thin pubescence; lateral margins, with stout setæ. Scutellum small, fringed with long setæ. Metathorax acclivous. Abdomen rather slender, broadened rather posteriorly, slightly pubescent, seven-segmented. Forceps of male large, almost flabelliform, not chelate, covered with setæ. Legs long and slender; coxæ stouter than the femora, setiferous at the tip and on the outer surface; femora very slender, slightly pubescent; tibiæ long and slender, in fore-leg shorter than tarsus, in intermediate leg about as long as tarsus, and in posterior leg nearly twice the length of tarsus, fore and intermediate tibiæ with practically no spines, but posterior tibiæ with two ranges; spurs rather short; tarsi pubescent, with a few small prickles. Wings about as long as abdomen, rather scaly near posterior margin, and hairy near the apex, remarkably rounded at the apical end, and cuneiformly narrowed at the base. Auxiliary vein rather more than one-third the length of the wing, disappearing just before reaching the margin; first longitudinal more than two-thirds the length of the wing; inner marginal cell one-third the length of the wing; petiole of second longitudinal less than the length from apex of inner marginal cell to the commencement of the third longitudinal; anterior branch of second longitudinal long, arcuated, running very gradually into costa; posterior branch very strongly arcuated, joining costa almost at the apex; costa slightly extended beyond point of junction; fork of third longitudinal slightly beyond fork of second; fourth longitudinal only slightly arcuated; fifth longitudinal more strongly arcuated, reaching margin some distance beyond apex of inner marginal cell; sixth longitudinal slender, long, but incomplete.

I have at present only received a specimen of one species belonging to this genus.

*Cyrtoneura hudsoni*, sp. nov. Plate X., fig. 4; Plate XIII., figs. 1, 2.

Length of antennæ, 0·179; size of body, 0·874 × 0·062; expanse of wing, 0·752 × 0·172.

Antennæ 2 + 15 jointed; first joint of scapus yellow, slightly longer than broad, cyathiform; second joint orange, short, cylindrical, length about equal to its diameter; both joints of scapus almost naked; all joints of flagellum black, but the first has a ring of light-yellow at its lowest end; length and diameter of joints decreasing slightly from below upwards; all the joints are covered with a black pubescence, and have a few stiff black hairs near the middle. Proboscis moderately long, grey above but black below. Palpi four-jointed; first joint grey, narrow, and short; second joint orange, long, and greatly swollen, clothed with yellow and black hairs; third moderately short and narrow, dark-brown, with a black pubescence; fourth about twice the length of the third, covered with black pubescence. Eyes emarginate, separated by a very narrow line just above the antennæ. Ocelli three, two lateral large, central one moderate; situated almost in a line. Vertex narrow. Thorax dark-brown, with a narrow yellow line down the centre, and two broad lateral lines meeting in a semicircle in front, and tapering towards one another posteriorly; another longitudinal lateral stripe just above the wing; the yellow is bordered with dark-brown, which becomes lighter away from the yellow stripes; surface covered with small black hairs, and a row of strong hairs is situated on each lateral margin. Scutellum and metathorax dark-brown. Epimera mottled dark-brown and light-yellow. Halteres with a slender pedicel, terminating in an orange-coloured club, dark at the base, and covered with a short pubescence. Abdomen of seven segments, dark-brown on the median line, but light-yellow on each side. Forceps of the male orange in colour. Legs long and slender; coxæ stout, light-yellow in colour, but shaded with dark-brown; femora dark-yellow, the two posterior pairs being dark in the centre; tibiæ brown, long and slender, clothed with short black hairs; the anterior tibiæ have a single spine, the posterior have two short spines each; short stiff hairs at intervals; tarsi dark-brown, clothed with black hairs of two sizes. Wings very broad at apex, but cuneiformly narrowed at the base, clothed with scattered scales, especially near the inner margin, and with hairs near the apex. Auxiliary vein rudimentary; first longitudinal ending in costa at about five-sixths the length of the wing; second and third longitudinals with a common petiole; anterior branch of second longitudinal very long, bending slightly downwards at the tip; posterior branch strongly bent, ending just before the end of the costa, near the apex of the wing; fork of the third longitudinal nearer the apex of the wing than that of the second; both branches feebly developed, and ending close behind the apex of the wing; both branches of fourth longitudinal well developed;

fifth longitudinal rudimentary. Large patch of brown at the apex, and another patch nearer the base.

This very fine and remarkable species has, so far, only been taken near Wellington. Mr. Hudson has kindly lent me a specimen for drawing up this description. I have no hesitation in creating a new genus for its reception.

NERVIJUNCTA, gen. nov.

Head nearly round, front not flattened. Eyes large, emarginate, almost meeting just in front of the ocelli. Ocelli three, large, situated almost in a line on the front. Palpi four-jointed, short—first joint small; second longer and considerably swollen, the broadest part being in the middle; third joint rather shorter than the second, cylindrical, and rather narrow; fourth joint longest, very slender. Antennæ shorter than the thorax; first joint of scapus short and broad, cupuliform; second joint twice the length of the first and not so broad, almost cylindrical; flagellum slender, cylindrical, 2 + 15 jointed, length of joints about three times their breadth, joints decreasing in diameter towards the apex of the antenna, pubescent, several stout setæ situated near the centre of each joint. Thorax highly arched, pubescent, with strong setæ on the lateral margins. Scutellum slim, circular, bordered with setæ on posterior margin. Metathorax acclivous. Abdomen rather flattened, seven-jointed, slender in front but becoming broad posteriorly. Forceps of male two-jointed, first joint almost spherical, crateriform at the apex, densely hairy; second joint double the length of the first, cylindrical, hairy. Legs slender; coxæ much stouter than the femora, almost naked; femora about twice the length of the coxæ, pubescent; tibiæ slender, in fore-leg rather more than half the length of the tarsus, in intermediate leg very slightly longer than tarsus, in posterior leg rather longer than tarsus and with two rows of few but rather long and slender spines; spurs very distinct; metatarsus long, that of intermediate and posterior legs with a few minute prickles. Wings larger than the abdomen, rounded at the apex and cuneiformly narrowed at the base, pubescent on the surface. Auxiliary vein a short tooth not joining the costa nor the first longitudinal; first longitudinal joining the margin at about two-thirds the length of the wing; inner marginal cell about one-third of the length of the wing; third longitudinal arising from the second beyond the apex of inner marginal cell; anterior branch of second longitudinal slightly arcuated, joining margin some distance in front of first longitudinal; posterior branch of second longitudinal joining the tip of costa almost at the apex of the wing; fork of third longitudinal situated just beyond the fork of the second, branches not

divergent; fourth longitudinal almost straight; fifth longitudinal arcuated; sixth incomplete, not reaching to apex of inner marginal cell, situated some distance from fifth longitudinal.

This genus is evidently closely allied to *Ditomyia*, but differs from it in the point of origin of the third longitudinal vein.

*Nervijuncta nigrescens*, sp. nov. Plate VIII., fig. 1.

Length of antennæ, 0·055; dimensions of body, 0·170 × 0·030; expanse of wing, 0·155 × 0·057.

Antennæ 2 + 15 jointed; first joint of scapus short, cyathiform, fuscous; second more than twice the length of the first, fuscous, but with a broad cinereous border on the upper end; all joints of flagellum black, slightly decreasing in length and diameter from the base upward; each joint with several small scattered hairs, and a zone of stiff hairs about the middle point. Palpi four-jointed—first joint small, nearly round; second joint long and rather broad, black, with long black hairs at its anterior end; third joint black, more slender, nearly naked; last joint cylindrical, brown, with a few stout black hairs at its anterior end. Eyes large, emarginate. Ocelli three, middle smaller than the two lateral, situated nearly in a row. Eyes almost contiguous, behind the antennæ. Vertex dark-brown, densely pubescent. Anterior portion and sides of thorax bright-golden, covered with golden hairs; central portion of thorax and scutellum dark-brown, the former ornamented with a few long stiff black hairs. Metathorax brown, but lighter than the mesothorax. Lower portions of epimera almost black. Abdomen very narrow anteriorly, but broadening posteriorly, consisting of seven segments; anterior portion of each segment dark-brown; posterior margin has a narrow band, smoky-grey in colour; all segments covered with moderately-long black hairs. Legs rather long and thin; anterior coxæ light-yellow, posterior coxæ becoming brown at the tips; femora dark-brown, long and narrow, covered with short stout black hairs; anterior tibia slightly longer than the femur, bearing one short spine at its end; posterior tibia much longer, ornamented with two spines, and bearing scattered short stiff bristles; all tibiæ and tarsi nearly black; first joint of tarsus very long, others decreasing gradually in size, thickly clothed with very short black hairs. Wings nearly entirely brown, surface clothed with scattered black slender hairs. Auxiliary vein rudimentary; first longitudinal nearly three-quarters the length of the wing; second and third longitudinals with a common but very short petiole arising from the apex of the inner marginal cell; petiole of second

longitudinal about the same length as its anterior branch; posterior branch ends in the termination of the costa just before the apex of the wing; third longitudinal very slender, apex of its fork slightly nearer the apex of the wing than apex of fork of second longitudinal; inner marginal cell apparently open between second and fourth longitudinals; both branches of fourth longitudinal strong, ending in the margin; fifth longitudinal not complete, and very thin. Forceps of male dark at base, but yellow towards their apex. Genital appendages of female dark-orange.

### HUTTONIA, gen. nov.

Head oval, almost round. Eyes emarginate, with a narrow line of division between them above the bases of the antennæ. Palpi moderately long, four-jointed; first joint very short, almost orbicular; second rather long and swollen, length about twice the breadth; third joint about as long as the second, narrow and cylindrical; third joint slender, rather longer than the others. Front short. Ocelli three, nearly in a straight line, the central one rather smaller than the others. Antennæ about as long as the thorax, 2+16 jointed; joints of scapus cupuliform, about as long as broad, slightly setose; flagellum rather long, joints about twice as long as broad, pubescent, a few setæ situated near the middle point of each joint, terminal joint very small and nipple-like. Thorax highly arched, pubescent, with setæ on the lateral margins. Scutellum small, semicircular, with setæ on the hind margin. Metathorax acclivous. Abdomen slightly flattened, seven-segmented, narrow in front but becoming broadened posteriorly Forceps of the male large, almost flabelliform, pubescent. Legs long and slender; coxæ stout, setose on the outer edge and on the apex; femora about twice as long as the coxæ, slightly compressed, pubescent; tibiæ long and slender, longer than the tarsi in the intermediate and posterior legs, and covered with two ranges of short and rather slender spines; spurs unequal, long; tarsi with small prickles on the under-surface. Wings rather narrow, cuneiform at the base and gracefully rounded at the apex, surface pubescent. Auxiliary vein entirely absent; first longitudinal short, running into the costa about half-way along the wing; inner marginal cell about one-third the length of the wing; anterior branch of second longitudinal running into the costa about two-thirds along the wing, posterior branch strongly arcuated, joining the tip of the costa at the apex; anterior branch of third longitudinal a mere rudiment extending a very little distance into the disc of the wing, posterior branch commencing in the disc a little beyond the fork of the second longitudinal; fourth longitudinal not quite joining the margin, disappears just before reaching the inner

marginal cell; fifth longitudinal strong, slightly arcuated; sixth longitudinal rudimentary, represented by a straight line of black hairs.

This genus is in some degree a connecting-link between the foregoing genera. I have not got sufficient material to ascertain its exact position.

*Huttonia tridens.* Plate VIII., fig. 2.
*Platyura tridens*, Hutton (Cat. N.Z. Diptera).

Length of antennæ, 0·078; size of body, 0·0245 × 0·038; expanse of wing, 0·225 × 0·071.

Antennæ 2 + 16 jointed; joints of scapus thick and cyathiform, light-yellow, fringed with black hairs; joints of flagellum compressed, oval in outline, the first nine joints yellow at the base, the centre is coloured brown, and the apical portion again is yellow; there is no sharp line of demarcation between the yellow and brown bands. Palpi yellow; first joint dark-yellow, long and thick, covered with short black hairs; second rather shorter than the first and slender, with very few black hairs; third and fourth same thickness as the second but much shorter, the latter being rather pointed; a few black hairs on third and fourth joints. Eyes emarginate, almost meeting above the bases of the antennæ. Front black round the ocelli, shading to black posteriorly. Collare light-yellow. Anterior portion of the thorax light-yellow, but bordered with a narrow streak of brown; three longitudinal bands blending together anteriorly behind the yellow band; central longitudinal band much shorter than the lateral ones, not extending more than half-way down the thorax; whole thorax covered with short black hairs. Epimera light-yellow above, but black just above insertion of the coxa. A very few long stout black hairs on the lateral and posterior margins of the mesothorax. Scutellum smoky-brown, fringed with six very long black hairs. Metathorax and pleuræ dark-brown. Halteres with rather a slender pedicel, bearing a densely cinereous club. Abdomen dark-brown, the posterior half of each segment yellow; a thin covering of black hairs on all the segments. Forceps of male light-yellow, ending in a black claw, and covered with short black hairs. Legs rather long; coxæ yellow, with a few black hairs on the outer side; femora darker, about twice the length of the coxæ; tibiæ darker, with short black hairs and longer spines; spurs moderately long, black; tarsi rather short, covered with short black hairs and a few spines; ground-colour dark-yellow. Wings slightly longer than the abdomen, with a slight dusky tinge, covered rather sparingly with black hairs. Veins dark-brown. A dark patch on the anterior branch of second longitudinal, extending to posterior

branch and to costa; another fainter patch about half-way between this and the apex, reaching from second longitudinal to costa; other fainter patches on the two branches of the third longitudinal.

I have only one specimen of this fine insect. It is the same specimen as that from which Captain Hutton's description of *Platyura tridens* was drawn. It was taken at Wellington. The very exceptional features in its neuration compel the creation of a new genus for its reception.

Genus MACROCERA, Meig.

Head broad, oval, flattened on the fore part. Eyes oval, a little emarginate on the upper side above. Ocelli three, of unequal size, in a triangle on the front, the foremost one smaller. Palpi four-jointed, cylindrical; the first joint small, the following ones of equal length, or the fourth somewhat lengthened. Antennæ 2 + 14 jointed, very long, frequently much longer than the body, projecting forward, arcuated; the first joint of the scapus spheroidal, the second more cupuliform; the first flagellar joint cylindrical, the upper ones setiform, pubescent, a little setiferous on the under side, the last two joints densely covered with hair and setæ. Thorax oval, highly arched. Scutellum small, almost semicircular. Metathorax highly arched. Abdomen flattened, almost cylindrical in the female, broadest in the middle, with seven segments in both sexes. Legs slender, long, the fore ones short; tibiæ spurred, the spurs small, lateral spines wanting. Wings hairy, or only microscopically pubescent, large, broad, with a very broad base; usually rather longer than the abdomen, half open in repose. Auxiliary vein complete, terminating in the costa, and united to the first longitudinal vein by the subcostal cross-vein; costal vein extending far beyond the tip of the second longitudinal vein, and almost reaching the apex of the wing; second longitudinal vein very much arched, forming a long-stalked fork, the anterior branch, always very short, lying in a very oblique position, terminating in the costa; fifth longitudinal vein more or less undulated.

This genus is evidently well represented in New Zealand, as I already possess specimens of four distinct species. One species, *M. antennatis*, is very fine, possessing antennæ three times as long as its body. Another species, *M. scoparia*, which, so far as I have been able to judge, is extremely common throughout the colony, is remarkable owing to the fact that the anterior fork of the second longitudinal vein is entirely wanting. This peculiarity, Mr. Skuse writes me, is not unknown in the *Macrocera*, but is apparently rare. I am unable to quote any other species showing the same peculiarity.

A. Wings microscopically haired.

*a.* Wings unspotted.

*Macrocera montana*, sp. nov. Plate VIII., fig. 3.

Length of antennæ, 0·247; size of body, 0·215 × 0·038; expanse of wing, 0·161 × 0·084.

Antennæ considerably longer than the body; joints of scapus short, dark-brown; lower joints of flagellum dark-yellow with black tips, clothed with scattered black hairs; last six or seven joints dark-brown to black, clothed with much longer hairs. Front brown. Thorax bright-yellow, slightly darker on the median line; on each side of it there is a line of stiff black hairs which taper towards one another, but do not coalesce; lateral margins of thorax bordered with long stiff black hairs. Pleuræ black. Scutellum fringed with a border of long stiff black hairs. Metathorax black with yellow sides. Abdomen very slender, compressed; each segment with anterior portion yellowish-brown, becoming dark-brown posteriorly, clothed with long scattered black hairs. Coxæ dull-yellow, black towards the tips; femora light-yellow, covered with short black hairs; tarsi and tibiæ brown, covered with dense black hairs. Wings shorter than the body, dull-yellow, with a microscopic pubescence. Veins umber-brown, with a row of black hairs on each; auxiliary vein joining the costa beyond the origin of the cross-vein; tip of first longitudinal vein not dilated; costal vein reaching the apex of the wing; inner marginal cell with a very pointed apex.

I have only one specimen of this insect, which was taken in a shady, damp gully on the Rimutaka Mountains, at an elevation of about 2,000ft. It is rather closely allied to *M. delicata*, Skuse, of New South Wales.

*Macrocera howletti*, sp. nov.

Length of antennæ, 0·242; size of body, 0·219 × 0·028; expanse of wing, 0·165 × 0·074.

Antennæ longer than the body; joints of the scapus yellow, very short; basal joint of flagellum dark-brown, densely clothed with short black hairs; all other joints much lighter in colour, central joints lightest; last five joints covered with moderately-long bristly hairs. Ocelli situated in a triangular black spot, but all the rest of the head is light- or orange-yellow. Thorax variously marked with yellowish-brown and golden-yellow marks; a very faint indication of the longitudinal lines of black hairs noticeable in the last species; lateral margins bordered with long black hairs. Scutellum light-yellow, bordered with long black hairs. Pleuræ and metathorax orange-yellow. Halteres with pedicel

almost white at the base, becoming cinereous towards the top; club much compressed, cinereous, thinly clothed with black hairs. Abdomen narrow, anterior part of each segment light-yellow, darkening to brown in the posterior portion; scattered stiff black hairs on all the segments. Coxæ light-yellow, with scattered black hairs; femora slender, with short black hairs; tibiæ and tarsi straw-coloured, densely clothed with stout but short black hairs. Wings smoky. Auxiliary vein not complete; transverse veins bounding inner marginal cell very slender; apex of first longitudinal not dilated. Apex of wing rounded. All veins straw-colour, with a single row of black hairs.

I have only one specimen, taken in the Ruahine Mountains, in January. This is very closely allied to the last species, but is separated from it by the colour of the antennæ and thorax, rounded tip to the wing, and very feeble development of the basal portions of the veins, and the incomplete auxiliary vein. If intermediate forms are subsequently discovered this may have to be linked with the last species.

### B. Wings distinctly haired.

*a*. Wings unspotted.
*b*. Wings spotted.

*Macrocera antennatis*, sp. nov.

Length of antennæ, 0·660; size of body, 0·218 × 0·044; expanse of wing, 0·260 × 0·088.

Antennæ three times the length of the body; joints of scapus orange-coloured, very short and thick; joints of flagellum all dark-brown, thickly clothed with short black hairs; joints becoming darker towards the apex of the antennæ, and the hairs longer and more numerous. Ocelli situated very close together on a small raised black triangular area. Crown cinereous, becoming orange posteriorly. Thorax dark-orange, marked variously with light-yellow; one median and two lateral lines of short black hairs; black hairs sparingly scattered over the thorax. Scutellum, metathorax, and pleuræ all dark-orange. Halteres with stout pedicel bearing oval-shaped cinereous club, clothed with black hairs. Abdomen depressed; first segment light-yellow; anterior portion of subsequent segments black, posterior portion yellow; last two segments black. Forceps of male orange. Abdomen sparingly clothed with long black hairs. Legs long and slender; coxæ short and stout, with a few stout black hairs; femora long and slender, clothed, like the tibiæ and tarsi, with numerous black hairs. Wings with faint tawny tinge; one small black patch at the apex, another at the junction of the second and third longitudinal veins, proceeding upwards

and towards the apex; apical half of wing thinly clothed with short black hairs. Auxiliary vein reaching the margin of the wing above the apex of the inner marginal cell; apex of first longitudinal considerably dilated; anterior branch of second longitudinal very short; fifth longitudinal complete, reaching the margin close to the fourth longitudinal.

I have only one male specimen of this very fine and distinct species. It was taken on the Ruahine Mountains, in January.

*Macrocera scoparia*, sp. nov. Plate IX., fig. 1.

Length of antennæ, 0·220; size of body, 0·121 × 0·032; expanse of wing, 0·165 × 0·066.

Antennæ about twice the length of the body; joints of scapus light-orange, very short and robust; flagellar joints long and slender; basal joints light-brown, but apical joints nearly black, all clothed with stout black hairs. Palpi short, black. Vertex black. Thorax golden-yellow; a broad brown stripe commences just behind the collare and extends down the centre of the thorax nearly to the scutellum; a lateral dark-brown stripe on each side, but not extending far beyond the point of insertion of the wings. Scutellum dark-brown. Metathorax dark-brown with yellow sides. Pleuræ dark-brown. Halteres smoky-white; club elongated, oval in shape, covered with short black hairs; first and third and sometimes other segments light- or dark-yellow; other segments black. Forceps of male yellow. Abdomen clothed with rather long black hairs. Legs pale-yellow, becoming darker towards the tarsus, covered all over with short black hairs; spurs of tibiæ short, dark-yellow; first joint of tarsus long, others very short. Wings longer than the body, almost hyaline, but shaded at the apex and at the petiole of the second longitudinal; covered all over with short black hairs. Auxiliary vein ending just before apex of inner marginal cell; apex of first longitudinal slightly dilated; second longitudinal without anterior branch; posterior branch ending some distance before the apex; costal vein ending a little before the apex.

This species is extremely common apparently throughout the colony. It may very commonly be taken on windows during all the summer months. It is easily distinguished from all other *Macroceræ* with which I am acquainted by the fact that the second longitudinal has no anterior branch.

### Genus Bolitophila, Hoffm.

Head small, roundish, fore part flattened. Eyes broadly oval, a little emarginate on the upper side above. Ocelli three, arranged on a somewhat bent line on the front. Palpi

prominent, incurved, cylindrical, four-jointed; first joint very small, the following of about equal length; the fourth the longest. Antennæ setaceous, pubescent, in the male as long as, in the female shorter than, the body; 2 + 15 jointed; the joints of the scapus cyathiform; the flagellar joints cylindrical, the terminal one very small, almost gemmiform. Thorax small, oval, highly arched. Scutellum small, roundish. Metathorax acclivous. Halteres large. Abdomen very long and slender; in the male linear, subcylindrical, eight-segmented without the anal joint; in the female nine-segmented, the last segment small. Legs long and slender; tibiæ with very short weak spurs, the fore tibiæ with a single range of spines on the inner side, and the hind pair with one range on the inner and two ranges of shorter and weaker spines on the outer side. Wings large, microscopically pubescent, as long as or somewhat longer than the abdomen, with obtusely cuneiformly narrowed base; incumbent in repose. Costal vein uniting with the tip of the third longitudinal at or somewhat beyond the apex of the wing; auxiliary vein complete, joining the costa, united to the first longitudinal by the subcostal cross-vein; third longitudinal vein with an anterior branch (which is sometimes wanting), the branch short, almost vertical, ending in the tip of the first longitudinal vein or in the costa; small cross-vein, short, situated almost midway between the origin of the third longitudinal vein and the inner end of the second posterior cell; fourth longitudinal vein starting from the base of the fifth longitudinal vein; fork of the fifth longitudinal vein united at its base to the fourth longitudinal vein by a small cross-vein; sixth longitudinal vein perfect.

The only New Zealand species of this genus that I have seen is *B. luminosa* (Sk.). The only specimens of this fly, so far as I know, were reared from larvæ by Mr. G. V. Hudson, of Wellington. The larvæ are abundant throughout the colony in dark, damp gullies, but whether they all belong to the same species is not so far determined. Though the larvæ are abundant the fly seems scarce, as I have never taken any; but this may be because the insect is a night-flier. The larva and metamorphosis of the insect are fully described by Mr. G. V. Hudson (Trans. N.Z. Inst., vol. xxiii., pp. 43–49, pl. viii.).

*Bolitophila luminosa*, Skuse (Trans. N.Z. Inst., vol. xxiii., p. 47). Plate IX., fig. 2; Plate XIII., fig. 4.

Length of antennæ, 0·090; size of body, 0·380 × 0·040; expanse of wing, 0·250 × 0·070.

Antennæ very slender, as long as the head and thorax combined; joints of scapus yellow, tinged with brownish; flagellar joints elongated, progressively diminishing in thick-

ness, brown. Hypostoma brown. Palpi yellow. Front and vertex black. Thorax black or very deep brown, levigate, with a median yellow line; the humeri and lateral borders pale-yellow or whitish; two convergent rows of short black hairs from humeri to scutellum; some black bristly hairs above the origin of the wings. Pleuræ deep-brown tinged with pale-yellow. Halteres pallid, the club black. Abdomen slender, subcylindrical, five times the length of the thorax, dusky-brown; the segments distinctly, especially the hindermost ones, tinged with yellowish anteriorly, densely clothed with very short black or brown hairs. Extremity and lamella of ovipositor yellow. Legs long and very slender; coxæ pale-yellow or whitish, the fore and intermediate pairs with the extreme apex and the hind pair with almost the apical half dusky-brown, trochanters dusky-brown; femora pale-yellow or whitish, the hind pair black at the apex; tibiæ and tarsi black, tibial spurs black; in the fore-legs the tibiæ and metatarsi of about equal length, the tarsi twice the length of the tibiæ. Wings shorter than the abdomen, pellucid, with a delicate yellowish tint, and almost the apical half infurcated with grey. Costal vein uniting with the tip of the third longitudinal vein somewhat beyond the apex of the wing; auxiliary vein terminating in the costa opposite or somewhat beyond the inner end of the second posterior cell, the subcostal cross-vein situated near its base; first longitudinal vein running straight into the costa, near a point before the tip of the posterior branch of the fourth longitudinal vein; third longitudinal vein greatly arcuated near its base, strongly arcuated near its tip; posterior branch of fifth longitudinal vein abruptly reaching the margin.

Though well acquainted with the larva, I have never taken the mature form of this insect. Mr. G. V. Hudson, of Wellington, has hatched out some of the larvæ, from one of which this description was drawn by Mr. Skuse.

### Genus Ceroplatus, Bosc.

Head small, broadly oval, flattened on the fore part. Eyes oval, sometimes a little emarginate on the inner side above. Ocelli three, on a curved line on the front. Palpi short, not incurved, with three or four joints; first joint small, the others large. Antennæ projecting forwards, shorter than the head and thorax together, very flat and broad, broadest in the middle, 2 + 14 jointed; joints of the scapus cotilliform, in some species the first joint prolonged in front; flagellar joints almost annular, the last joint conical or gemmiform. Thorax oval, highly arched. Scutellum almost semicircular. Metathorax arched. Abdomen cylindrical, or a little flattened,

with seven segments in both sexes. Legs long; tibiæ spurred, the spurs of unequal length; lateral spines missing or exceedingly small, one range on the inner side of the fore tibiæ, one on the inner side and two on the outer of the hind tibiæ. Wings microscopically pubescent, shorter than the abdomen, base broad and rounded off, incumbent in repose. Costal vein extending beyond the tip of the second longitudinal vein, ending before the apex of the wing; auxiliary vein complete, terminating in the costa before the origin of the third longitudinal vein; subcostal cross-vein missing; second longitudinal vein forming a long-stalked fork with a short anterior branch, the latter running into the costa, sometimes into the first longitudinal vein; petiole of the third submarginal cell always short; fifth longitudinal vein complete.

I have specimens of three species of this genus, all of which are of small size.

*Ceroplatus dendyi*, sp. nov. Plate IX., fig. 3.

Length of antennæ, 0·046; size of body, 0·198 × 0·038; expanse of wing, 0·160 × 0·066.

Antennæ dark; scapus with lowest joint moderately long and very thick, second joint about as long as broad, black, with a faint tawny tinge; joints of flagellum considerably dilated and flattened, broadest at the base, and gradually decreasing in width towards the apex; surface pubescent, with stiffer hairs on the margins, all joints of flagellum black. Ocelli in a triangle, central, much smaller than the two lateral. Crown dark-brown or black, pubescent. Thorax dark-brown, with two lighter patches over the point of insertion of the wings, and two broad indistinct lighter lines commencing near the collare and coalescing some distance in front of the scutellum. Thorax densely covered with black hairs. Scutellum black, its posterior broader, fringed with black hairs. Metathorax brown. Pleuræ dark-brown. Halteres with almost white pedicels; club brown for basal three-quarters, apical quarter white. Abdomen black, with brown patches on the middle segments. Forceps of male cinereous. Abdomen and forceps covered thinly with black hairs. Legs moderate; coxæ straw-coloured, with black hairs, darker at the tips; femora, tibiæ, and tarsi straw-coloured, but covered with black hairs that become more numerous towards the distal extremities; one spur on each anterior tibia, and two, the inner larger than the outer, on each posterior tibia; all black. Wings smoky, with a large dark patch at the apex, and another smaller one proceeding transversely from the costa to the petiole of the third longitudinal. Auxiliary vein joining the costa just before

the origin of the third longitudinal vein; anterior branch of second longitudinal short, joining the costa a little beyond the apex of the first longitudinal; costal vein extending some distance beyond the apex of second longitudinal, but not quite reaching the apex of the wing; posterior branch of third longitudinal and subsequent veins do not quite reach the margin; sixth longitudinal terminating some distance before the margin. Surface of wing microscopically haired.

I have only two specimens of this insect, one of which was reared by Dr. Dendy from larvæ, and the other by myself. The larvæ are found beneath logs, and apparently live on the small mould fungi that grow in such localities. The insect is closely allied to *Ceroplatus mastersi* (Skuse) of New South Wales. The larvæ from which my specimens were bred were found by Dr. Dendy in Alford Forest. Unlike the larvæ of *C. mastersi*, those of the present species are certainly not luminous. The form of the larvæ is totally different from that of the diagram given in Theobald's "British Flies," vol. i., page 96.

*Ceroplatus hudsoni*, sp. nov.

Length of antennæ, 0·056; size of body, 0·168 × 0·022; expanse of wing, 0·143 × 0·049.

Antennæ about as long as head, and thorax very similar to those of *C. dendyi*. Thorax, scutellum, and pleuræ black, the two former covered with stiff black hairs. Halteres with a stout pedicel bearing a black pubescent knob. Abdomen black, the posterior portion of each segment being dark-grey; abdomen covered with stiff black hairs. Legs rather long; coxæ black, hairy towards the extremity; femora with the two extremities black but light-yellow in the central portion, covered all over with short black hairs; tibiæ and tarsi straw-coloured, clothed with short stiff black hairs. Wing slightly smoky; an indistinct patch of dark colour near the apex, which disappears at the anterior branch of the third longitudinal, and does not extend further from the apex than the fork of the second longitudinal; another patch extending from the junction between second and third longitudinals nearly to the former patch; both patches much lighter than in *C. dendyi*. First longitudinal very close to margin of the wing; veins brown, not black as in *C. dendyi*.

I have only one specimen of this insect, taken by Mr. G. V. Hudson in the neighbourhood of Wellington. It closely resembles *C. dendyi*, but can be distinguished by its smaller size, darker colour, narrower and lighter wings, and the colour of the coxæ.

*Ceroplatus leucoceras*, sp. nov.. Plate XIII., fig. 3.

Length of antennæ, 0·044; size of body, 0·170 × 0·022; expanse of wing, 0·110 × 0·044.

Joints of scapus dark-brown, short and robust, upper edge of each joint fringed with brown hairs; flagellum greatly flattened, first six joints light-yellow, bordered at the edge with short black hairs; next six joints black, fringed with black hairs; last two joints light-yellow, the terminal one bearing a nipple-like projection; first and thirteenth joints considerably darker than any of the others; broadest part of antennæ about the fourth and fifth joints of flagellum. Head black, covered with black pubescence. Thorax black, lighter in front, with very indistinct dark-brown markings covered with moderate black hairs. Scutellum black, bordered with black hairs. Metathorax dark-brown. Pleuræ cinereous. Halteres with stout pedicels; knob oval, cinereous at the base but white at the tip. Abdomen rather elongated, black, third fourth and fifth segments with the anterior portion dusky-white; everywhere covered with black hairs. Forceps of male dark, cinereous, densely pubescent. Legs rather short; coxæ cinereous at the base, almost black at the tip; femora black above, but dusky below; tibiæ and tarsi dusky; all joints of the leg covered with black hairs; all spurs black, moderately long. Wings slightly smoky; large patch of dark shading at the apex, extending as far as the fork of the second longitudinal vein, becoming lighter towards the inner margin; another patch extending from the junction between the second and third longitudinal to a little beyond the fork of the third longitudinal, reaching very little below the third longitudinal but extending to the margin; a small patch, comparatively light, near the end of the posterior branch of the fourth longitudinal. Auxiliary, first, second, and posterior branch of fourth longitudinal vein very distinct and prominent; anterior branch of second longitudinal reaching the margin about one and a half times its own length from the apex of the first longitudinal; costa extending a little beyond apex of second longitudinal, not reaching apex of the wing. Surface of the wing microscopically haired.

I have only one specimen of this very distinct and beautiful little species. It was obtained in native scrub close to Wanganui in January.

## Genus PLATYURA, Meig.

Head small, broadly oval, the fore part flattened. Eyes oval, a little emarginate on the inner side above. Ocelli three, of unequal size, near together in a triangle on the broad front, the middle one smaller. Palpi prominent, incurved, four-jointed; the first joint small, the second shortened-oval, as long as or somewhat shorter than the third, the third and fourth joints cylindrical, the fourth longest. Antennæ as long as the head and thorax taken together or even longer, rarely

shorter; arcuated, projecting forwards, somewhat compressed at the sides, or cylindrical, gradually diminishing towards the tip, 2 + 14 jointed; joints of the scapus distinctly set off, the first cyathiform, the second one more cupuliform; the flagellar joints compact. Thorax oval, highly arched. Scutellum small, almost semicircular. Metathorax arched. Abdomen slender, with seven segments in both sexes, flattened, claviform, in the male somewhat cylindrical at the base, rarely entirely cylindrical, always terminating in a forceps. Legs long; femora somewhat thickened, shorter than the tibiæ; tibiæ spurred; very small lateral spines, one inner and two outer ranges on the fore tibiæ without spines, and the hind pair with two ranges of lateral spines which are so small as to be only perceptible with a lens. Wings somewhat broad, base rounded off, as long as the abdomen or a little longer, incumbent in repose, microscopically pubescent. Costal vein extending beyond the tip of the second longitudinal vein, terminating some distance from the apex of the wing; auxiliary vein ending in the costa, rarely broken off, usually united to the first longitudinal vein by the subcostal cross-vein; anterior branch of the second longitudinal vein very short, ending either in the first longitudinal vein or in the costa; third submarginal cell always with a very small petiole; fifth longitudinal vein complete or incomplete.

This genus is well represented in New Zealand. In those species of which I have been able to make a thorough examination the males and females differ considerably in appearance. Several kinds can be found on window-panes.

### B. Anterior Branch of the Second Longitudinal running into the Costa.

*a.* Fifth longitudinal vein reaching the posterior margin.

*Platyura magna*, sp. nov. Plate XIII., figs. 5–7.

Male. Length of antennæ, 0·095; size of body, 0·374 × 0·040; expanse of wing, 0·258 × 0·079.

Antennæ rather shorter than head and thorax together; joints of scapus short, cinereous, cyathiform; joints of flagellum very slightly dilated, black, naked, terminal joint longer than the others, rounded anteriorly; fourth and fifth joints mark the broadest part of the flagellum. Palpi dark-orange, with a few scattered short black hairs. Head black, shining. Thorax with a broad central black stripe extending from the collare almost to the scutellum; two broad lateral stripes commencing some distance behind the collare and coalescing about opposite the insertion of the wings with the central stripe; rest of the thorax dark-orange, with a silvery sheen; the whole surface covered with black hairs. Scutellum black, bordered with a fringe of stout

black hairs. Metathorax and pleuræ yellow, but with a bright-silvery sheen, due to the presence of a minute silvery pubescence. Halteres with a stout orange pedicel, terminating in a moderate knob, orange at the base but darker at the apex, covered with a black pubescence. First two segments of abdomen slender, black; third segment dark-orange, with a dense covering of black hairs; fourth segment bright-orange, with few black hairs; fifth segment dark-orange; the last two segments black, and covered thickly with black hairs. Base of forceps dark-orange, becoming black at the apex, and ending in two horny chelæ. Legs moderately long; coxæ orange, with a few black hairs at the tip; femora dark-orange, covered with short black hairs; tibiæ and tarsi dark-orange, but the close covering of hairs on the tarsi makes them appear almost black; spurs stout, black. Wings with a fulvous tinge, especially near the costal margin; a black patch extending from the fork of the second longitudinal to the apex, very dark near the costal margin, but shading away towards the inner margin; another feebly-shaded spot near the end of the fifth longitudinal, extending a little beyond the fourth longitudinal, but not extending any distance towards the anterior margin. Veins yellow at the base, but shading into black at the apex of the inner marginal cell; costal vein terminates where the second longitudinal joins it; two branches of the third longitudinal terminate close together, and the apices of the fourth and fifth longitudinals close together. Wings microscopically haired.

Female. Length of antennæ, 0·079; size of body, 0·385 × 0·071; expanse of wing, 0·242 × 0·094.

Joints of scapus bright-orange, covered with short black hairs; joints of flagellum as in the male. Head black, but thorax orange, with silver sheen marked with dark-orange in much the same way as the male is marked with black. Scutellum dark-orange, fringed with black hairs. Metathorax and pluræ with a beautiful silvery sheen. All segments of abdomen dark-orange mottled with black, and covered with black hairs. Legs rather darker all over than in male. Wings with more pronounced fulvous shade, and less conspicuously shaded than in male. Sides of abdomen covered with a less-evident silvery tomentum than the pleuræ.

I have only one male and one female specimen of this fine and remarkable insect; they were taken together, at an elevation of about 1,000ft., on the Ruahine Mountains, in the month of January.

*Platyura agricola*, sp. nov.

Male. Length of antennæ, 0·064; size of body, 0·203 × 0·033; expanse of wing, 0·157 × 0·055.

Antennæ 2 + 14 jointed; joints of scapus about as long as broad, black, fringed with black hairs; joints of flagellum moderately stout, base of lowest joint fuscous, all the rest black, slightly pubescent. Second joint of palpus black, third and fourth joints about equal in length, light-yellow covered with minute yellowish pubescence and a few scattered black hairs. Epistome black, covered with black hairs. Vertex smoky-grey with moderately long black hairs, and covered with minute silvery pubescence. Thorax covered with minute silvery pubescence, except a median and two lateral black stripes whose surface is shining; one median line of strong black hairs, which are also scattered all over the surface except on the black stripes. Scutellum black, but covered with minute silvery pubescence and fringed with strong black hairs. Metathorax and pleuræ black, but with pubescence. Halteres with stout pedicel bearing large oval fulvous clubs apparently naked. Abdomen black, but often with dull-orange patches on the posterior portions of the third, fourth, and fifth segments; all segments with numerous black hairs. Forceps of male large, dull-orange at the base, but darkening upwards, becoming black at the tips. Legs rather long; coxæ straw-coloured, darker on the outer surface; femora straw-coloured, covered with short black hairs; tibiæ and tarsi darker and more thickly covered with black hairs; several rows of spines on the tibiæ; spurs rather long, black. Wings with yellowish tinge, surface covered with minute black pubescence. All veins strong, black but lighter near the base; costal vein extending beyond junction with second longitudinal, but ending abruptly before the apex; anterior branch of second longitudinal about equal in length to petiole of third longitudinal.

Female. Length of antennæ, 0·050; size of body, 0·108 × 0·044; expanse of wing, 0·176 × 0·073.

Antennæ more slender than those of the male; joints of scapus light-brown; basal and terminal joint of the flagellum much longer than any others; basal joint dark-brown, others black. Thorax tawny, the black marks being represented by dark-brown stripes which unite in a broad patch in front of the scutellum. Scutellum tawny, with a fringe of black hairs. Metathorax and pleuræ dark-brown. Halteres as in the male. Abdomen much broader and of a lighter colour than in the male, all the segments being bordered posteriorly with tawny-red. Legs and wings as in the male, but apex of the wing much rounder.

I have assumed that these are male and female forms of the same insect, for, though both forms are extremely common about Lincoln, I have never captured a female of the one or a male of the other. They can be taken all through

the summer at Lincoln, but I have not taken them elsewhere.

*Platyura flava*, sp. nov.

Length of antennæ, 0·038; size of body, 0·137 × 0·016; expanse of wing, 0·115 × 0·042.

Antennæ 2 + 14 jointed; joints of scapus yellowish-grey, first joint rather broader than long, second about as long as broad, both covered with a silvery pubescence; joints of flagellum black, with a pubescence giving silvery reflections. Head black, with a very short, rather inconspicuous, silvery pubescence. Thorax light-yellow anteriorly, darkening to dark-yellow posteriorly, shaded with black, but without any distinct or definite markings; whole surface covered with moderately stiff black hairs. Scutellum dark-brown, fringed with black hairs. Metathorax and pleuræ dark-tawny. Halteres with a stout pedicel bearing a club, yellow at base but almost white at the top. Abdomen dark-tawny on the back but lighter on the sides, and the posterior margin of each segment almost black; thinly covered with black hairs. Coxæ bright-yellow, with a few black hairs on the outer side near the tip; femora darker, covered with short black hairs; tibiæ and tarsi with light ground-colour, but rather thickly clad with black hairs, the former with a few scattered spines in addition; spurs black. Wings almost hyaline. Auxiliary vein rather faint; first longitudinal joining costa about two-thirds of its length; anterior branch of second longitudinal about as long as part of costa between its apex and that of first longitudinal; costal vein extending some distance beyond the apex of second longitudinal, but not reaching apex of the wing; all the veins dark-brown or black.

I have only one rather imperfect specimen of this insect, taken at Lincoln in August. A specimen taken at Wanganui differs but slightly from this insect, and is perhaps a representative variety of the North Island.

## Genus SCIOPHILA, Meig.

Head small, flattened on the fore part, sitting deep in the thorax, of rounded oval shape owing to its high vertex. Eyes remote in both sexes, oval, a little emarginate on the upper side above. Ocelli three, arranged near one another in a triangle on the broad front, the anterior one very small. Proboscis very short, not prominent. Hypostoma more or less broad. Palpi prominent, incurved, four-jointed, the first joint very small, the second shorter than the third, the fourth as long as or longer than all three together, seldom shorter than them. Antennæ projecting forward, arcuated, those of the male always longer than those of the female, in the latter often

only as long as the head and thorax together, somewhat compressed, 2 + 14 jointed; joints of the scapus distinct, cyathiform, setose at the apex; flagellar joints cylindrical, with downy pubescence. Thorax highly arched, oval. Scutellum small, semicircular. Metathorax acclivous. Halteres with an oblong club. Abdomen slender, with seven segments, narrowed at the base, generally claviform, especially in the male, somewhat flattened posteriorly; in the male terminating in a short forceps, in the female in a short non-projecting ovipositor with two terminal lamellæ. Legs long; femora with a fringe of hair on the lower side; tibiæ spurred, the fore pair with two, the hind pair with three ranges of lateral spines, of which those on the inner side are particularly short and delicate; coxæ elongated, the fore pair hairy on the front, the intermediate pair only at their apex, the hind pair with a row of setaceous hairs on their outer sides. In the male of some species the coxæ of the intermediate legs have on the inner side a long arcuated spine; these spines terminate in a double hook-shaped curved point, usually of a dark colour. Wings microscopically pubescent, longish-oval, with rounded-off base, a little longer than the abdomen. Tip of the costal vein uniting with the tip of the second longitudinal vein at the apex of the wing, rarely before it; auxiliary vein terminating in the costa not beyond the anterior branch of the second longitudinal vein; base of the second posterior cell lying either before, under, or beyond the origin of the third longitudinal vein, but always before the base of the third submarginal cell, and never so far forward as to come under the anterior branch of the second longitudinal vein; fifth longitudinal vein incomplete, usually broken off opposite the middle of the second posterior cell, sometimes disappearing before the base of the second posterior cell.

*Sciophila fagi*, sp. nov. Plate X., fig. 1.

Size of body, 0·174 × 0·032; expanse of wing, 0·132 × 0·074.

Joints of scapus short, not more than half their length, light-yellow, with a few black hairs; first joint of flagellum yellow but clouded, subsequent joints black, length about four times their breadth, covered with very fine glistening black hairs. Palpi long and slender, clouded straw-colour; first joint short, slightly hairy; second joint about twice the length of first, scattered black hairs on its surface; third joint more slender and twice the length of the second; fourth joint still more slender and darker in colour, about half as long again as the third. Vertex almost black. Thorax yellow, marked with tawny; two lateral rows of black hairs inclined to one another and meeting before the scutellum, also a median

row, but much shorter, not half the length of the thorax; sides of thorax with scattered black hairs. Scutellum testaceous, with two long black hairs on its posterior margin. Metathorax almost black posteriorly; pleuræ brown. Halteres with stout pedicels bearing black hairs; clubs almost white, with short stout black hairs. Abdomen of seven segments, the posterior portion of each segment being dark-yellow. Forceps of male black, covered with black hairs. Legs long and slender; coxæ very light yellow, with black hairs; femora, tibiæ, and tarsi darker, more densely covered with hairs; a few short black spines on the tibiæ, and shorter ones on the tarsi; spurs black, but rather short. Wings smoky, covered with black hairs. Auxiliary vein rather faint, rather more than one-third the length of the wing; first longitudinal ending rather near the apex of the wing; second longitudinal ending in costa slightly before apex of wing; costa continued to apex; subcostal cross-vein below apex of auxiliary; anterior branch of third longitudinal disappears about half-way from the fork to the margin of the wing; posterior branch very faint; anterior branch of first longitudinal almost straight, posterior rather wavy; fifth longitudinal straight, but not nearly reaching the margin.

I have only one specimen of this insect, and, unfortunately, the antennæ are not entire. The peculiarities of its neuration perhaps entitle it to be the type-species of a new-genus.

*Sciophila (?) hirta*, n. sp. Plate IX., fig. 5.

Size of body, 0·132 × 0·030; expanse of wing, 0·165 × 0·069.

Antennæ not perfect; joints of scapus dark-brown, nearly cylindrical, breadth nearly as great as their length; flagellum nearly cylindrical, no appreciable gap separating the joints, covered all over with a soft light-yellow pubescence. Palpi very slender but not long, light-yellow. Vertex black and shining. Thorax black and shining, a dark-yellow humeral patch on each anterior corner, behind which there is a patch of long black hairs. Abdomen black and shining, and covered with a close coating of stiff black hairs. Legs rather slender; coxæ pale-yellow at the base but darker at the tip, covered with black hairs; femora dark-yellow, clothed with black hairs; tibiæ dark-brown, considerably dilated at the extremity, marked with longitudinal rows of black hairs, with spines at intervals; spurs very light yellow; tarsi much darker and more densely clothed with black hairs than the tibiæ. Wings light-brown, becoming much darker at the first longitudinal vein; surface covered with scattered black hairs. Auxiliary vein ending blindly, not extending as far as the transverse vein; first longitudinal extending about four-fifths

of the distance along the wing; second longitudinal joining the tip of the costa almost at the apex of the wing; anterior branch comparatively long, situated some distance from the transverse vein; vein connecting second and third longitudinals very faint; apex of fork of third longitudinal situated some distance beyond end of marginal cell; anterior branch of third longitudinal disconnected at a point rather nearer the base than the middle of the marginal cell; fifth longitudinal almost parallel to and close beside posterior branch of fourth longitudinal, but not reaching the margin.

I have only one, and that rather an imperfect specimen, of this insect, taken in *Fagus* bush, at the base of Mount Torlesse, in March. It shows more affinities with *Sciophila* than with any other genus described in Mr. Skuse's Monograph, and I have therefore placed it in that genus. It differs from it in the position of the anterior branch of the second longitudinal, and in the disconnection of the anterior branch of the fourth longitudinal; while the rudimentary condition of the auxiliary vein is extremely exceptional in *Sciophila*. I hesitate to establish a new genus on such a poor specimen, but feel confident that the insect will not long be left in this genus.

## Genus Parvicellula, gen. nov.

Head oval. Eyes large, emarginate, nearly meeting below the antennæ. Proboscis short. Palpi short, first joint very short, the others about equal in length, except the fourth, which is rather longer. Front almost triangular. Three ocelli, the middle one much smaller than the others, arranged in a slightly-curved line. Antennæ about as long as the thorax, 2+14 jointed; first joint of scapus very short, much broader than long, second joint about as long as broad, setose on the upper surface; flagellum stout, joints rather longer than broad, densely pubescent. Thorax very highly arched, pubescent, setaceous on anterior and lateral margins. Scutellum small, nearly circular, bordered posteriorly with setæ. Metathorax steep. Abdomen rather flattened, seven-jointed, hirsute. Legs rather slender; coxæ stout, slightly hairy on the outer side; femora half as long again as the coxæ, rather slender, compressed, hairy; tibiæ rather stout, in fore and intermediate legs shorter than the tarsi, in the posterior legs about the same length as the tarsi, a few scattered spines on the fore tibiæ, two ranges of few spines on intermediate tibiæ, and two ranges of well-developed spines on the posterior legs; spurs stout; intermediate and hind tarsi with small prickles on the inner side. Wings about as long as the abdomen, rounded at the apex, with fairly pronounced anal angle, surface thickly covered with hairs. Auxiliary vein rather stout,

less than one-third the length of the wing, subcostal cross-vein situated near its apex; first longitudinal vein ending at about two-thirds the length of the wing; marginal cross-vein situated just beyond subcostal; petiole of second longitudinal very short, so submarginal cell is almost triangular; second longitudinal running into the costa some distance before the apex; costa prolonged beyond its tip, but not reaching the apex; third longitudinal rather indistinct, the apex of its fork situated some distance beyond apex of inner marginal cell, branches slightly divergent; fourth longitudinal unbranched; fifth and sixth longitudinals absent.

I have specimens of but one species of this genus, but the neuration is so distinct that I think I am justified in establishing a new genus for it.

*Parvicellula triangula.* Plate X., fig. 2; Plate XIII., figs. 8, 9.

Length of antennæ, 0·038; size of body, 0·132 × 0·033; expanse of wing, 0·115 × 0·057.

Antennæ 2 + 14 jointed; first joint of scapus very short, pale-yellow, second joint pale-yellow, cyathiform, the margin of the upper side ornamented with a few stiff black hairs about as long as the joint; first two joints of flagellum yellow, but antennæ gradually darkening towards the tip; all joints much the same length, centre ones bulging in the middle, terminal joints more cylindrical; all joints covered with soft pubescence giving silvery reflections; all joints rather longer than broad. Palpi incurved, cinereous; first joint short, second rather longer and thicker, clothed with black hairs; third and fourth slender and short, with a few short black hairs. Proboscis slightly protruding, hairy. Ocelli three, one situated close to the inner margin of each eye, the third almost in a line between them. Vertex black and shining, with a few black hairs. Thorax dark-tawny, with indistinct central and lateral black bands, covered with a minute pubescence and long golden hairs. Scutellum tawny, with golden hairs. Metathorax black, with golden hairs on its posterior margin. Pleuræ and epimera black. Abdomen of seven segments, black, but thickly covered with long golden hairs, slightly depressed, broadest in centre. Lamellæ of female white, covered with light-coloured hairs. Halteres very light yellow, covered with a minute pubescence. Legs of moderate length; coxæ smoky at the base, light-yellow in the middle, and black at the apex, the apical portion clothed with long golden hairs; femora dark at the tip; tibiæ about half as long again as the femora, rather stout, with many short black spines and a dense covering of black hairs; tarsi slender, straw-coloured, with a dense covering of short black hairs and spines on the posterior

surface. Wings with a yellowish tinge, especially near the costal margin and close to the veins; surface rather thickly covered with black hairs. Veins brown, with a central row of black hairs; auxiliary vein ending in costa at about one-quarter the length of the wing; first longitudinal joining costa at about two-thirds length of the wing; second longitudinal joining costa some distance before apex; costa continued beyond this point, but not nearly reaching the apex; subcostal vein situated just before marginal cell, latter very short, almost triangular; petiole of third longitudinal not long; fourth longitudinal not forked.

I have three specimens of this insect, two of which were taken at Lincoln in February, and the other in Christchurch in June.

A male specimen has almost identical measurement with the female, but it has black forceps. The legs are very much lighter in colour than those of the female, more especially the tarsi and tibiæ; the spurs are light-yellow. The veins of the wing are light straw-colour instead of brown.

### Genus TETRAGONEURA, Winn.

Costal vein extending far beyond the tip of the second longitudinal vein, but not reaching the apex of the wing; auxiliary vein small, bent posteriorly, ending in the first longitudinal vein far beyond the marginal cell, or shortened to a tooth; the marginal cell far beyond the middle of the first longitudinal vein; inner marginal cell much lengthened; fork of the third longitudinal vein with a moderately-long petiole; base of the second posterior cell lying before the base of the third submarginal cell. Surface of the wing microscopically pubescent.

The above short diagnosis is the only reliable one to which I have access at present. I hesitate to add other characters, fearing that my species is not sufficiently typical.

*Tetragoneura nigra*, n. sp. Plate XIII., figs. 10, 11.

Length of antennæ, 0·044; size of body, 0·077 × 0·014; expanse of wing, 0·077 × 0·033.

Antennæ about as long as the body; joints of scapus pale-yellow, cyathiform; joints of flagellum barrel-shaped, but situated on pedicels; length slightly greater than their diameter, the first three pale-yellow, those nearer the end of the antennæ; all the joints covered with soft hairs with silvery reflections. Vertex black, with a few black hairs. Thorax dull-black, a median and two V-shaped lateral marks rather more intense in shade; surface covered with short black hairs, and the margins with strong thick black hairs incurving over the thorax. Scutellum black, with two long black hairs

near the posterior margin. Metathorax and pleuræ black. Halteres light-yellow; the club oval in shape, with an almost imperceptible black pubescence on its edges. Abdomen black, with a shining granulated surface on which there is a thin covering of black hairs. Legs rather stout; coxæ light-yellow, with a few dark hairs on its darkened tip; base of femora rather dark as well as the distal portion, central portion light-yellow but covered all over with black hairs; femora considerably dilated; tibiæ rather short, slightly dilated at the end, ground-colour yellow but thickly covered with short black hairs, the posterior tibiæ with two ranges of black spines, intermediate tibiæ also with black spines but not so conspicuous; tarsi rather short, with much shorter spines, but otherwise much the same as the tibiæ; all spurs black. Wings with a slight brownish tinge. Costal vein extending a long distance beyond tip of second longitudinal, but not extending to apex of wing; apex of second posterior cell nearer the base of the wing than the apex of the third submarginal cell; fifth longitudinal reaching to apex of second posterior cell. Surface of wing covered with black hairs.

I only possess one specimen of this insect, which was obtained at Lincoln College in the month of December.

### Genus ANEURA, gen. nov.

Head rather small, oval, deeply imbedded in the thorax. Eyes oval, not emarginate. Proboscis short. Palpi long and slender; first joint about as long as broad; second longer than broad, but stout; third long, cylindrical, and slender; fourth longer than all the others put together, very slender. Ocelli three, the central one much the smallest. Antennæ 2 + 14 jointed; the joints of the scapus very short, cupuliform, slightly setose; joints of flagellum four times as long as broad, gradually decreasing in diameter towards the apex, terminal joint very narrow, densely pubescent. Thorax highly arched, smooth but for three longitudinal rows of hairs converging to a point in front of the scutellum; lateral margins slightly setiferous. Scutellum small, semicircular, setiferous on the posterior margin. Metathorax steep. Abdomen slightly compressed from the side. Legs long and slender; coxæ rather short, not more than half the length of the femora, slightly setose; femora slender, those of the posterior legs compressed, hairy; tibiæ of fore-legs about the same length as the metatarsus, of the intermediate leg about the length of the whole tarsus, and those of the posterior legs longer than the tarsus; posterior tibiæ with two rows of scarce, short, and feeble spines; spurs small and feeble; tarsi long and slender, with a few very small prickles on the under-

side. Wings oval, rounded at the apex, and anal angle not prominent, shorter than the abdomen, surface hairy. Auxiliary vein more than one-third the length of the wing, but not half its length; no subcostal cross-vein; first longitudinal slightly arcuated, ending near the apex of the wing; second longitudinal arcuated, joining costa just before the apex; costa prolonged beyond the tip of the second longitudinal and reaching the apex; basal portion of second longitudinal about one and a half times the length of the submarginal cross-vein, which is situated some distance before the apex of the auxiliary vein; petiole of the third longitudinal about the same length as the anterior branch, branches divergent; apex of the second posterior cell situated before the apex of the second submarginal cell; branches of fork of fourth longitudinal very divergent; fifth longitudinal incomplete.

This genus differs from most of the others in the subsection in the absence of the subcostal cross-vein. It is closely allied to *Boletina*.

*Aneura boletinoides*, sp. nov. Plate X., fig. 5; Plate XIII., figs. 12, 13.

Length of antennæ, 0·093; size of body, 0·154 × 0·016; expanse of wing, 0·132 × 0·049.

Antennæ 2+14 jointed, longer than head and thorax together; joints of scapus short, nearly globular, very light yellow; first joint of flagellum light-yellow at base, but upper portion and all succeeding joints dark-brown; length of joints about three times their diameter, all rather thickly clotted with black hairs; terminal joint slender but rounded. Palpi very dark brown; first joint rather slender, second long and slightly swollen, third shorter and more slender, fourth longest and more slender than any others. Thorax bordered all round with light-yellow, central portion light-brown; one central row of short black hairs; two lateral rows, the outer one consisting of long hairs; central row short, but two inside lateral rows meet in front of scutellum. Scutellum light-yellow, bordered with long black hairs. Metathorax and pleuræ brown. Pedicel long and slender, supporting rather a large club, both pedicel and club being covered with a short black pubescence. Abdomen light-yellow, the posterior margin of each segment especially on the sides being brown; surface with scattered long slender black hairs. Lamellæ of female dark-brown, and forceps of male rather large, black. Abdomen of male with broader brown borders on posterior portion of abdomen than in female. Legs long and slender; coxæ rather short, very light yellow; femora rather long, light-yellow, but covered with black hairs; tibiæ and tarsi light-coloured, but covered with black hairs, and

bearing a few black spines; spurs black. Wings with a slight brown tint, surface covered with black hairs. First and second longitudinal veins black, others very light brown; auxiliary vein about one-third the length of the wing; no subcostal cross-vein; first and second longitudinal veins curved near the end; petiole of third longitudinal long; fifth longitudinal not reaching fork of fourth.

I have four specimens of this insect, all of which were taken at the foot of Mount Torlesse, in *Fagus* bush, in March and November.

Genus CYCLONEURA, gen. nov.

Head longer than broad. Eyes large, but well separated on the front. Antennæ and palpi not seen. Thorax almost globular. Abdomen of seven segments in the male. Wings rather narrow. Auxiliary vein rudimentary; first longitudinal ending about half-way along the anterior border; second longitudinal vein ending some distance before the apex; costal vein continued beyond the end of the second longitudinal, but not reaching the apex of the wing; anterior branch of third longitudinal ending at a point a little beyond the apex of the wing; posterior branch wanting; anterior branch of fourth longitudinal ending at about one-third of length of inner margin of the wing; fifth longitudinal vein complete, joined at about half its length by a vein perhaps corresponding to the posterior branch of the fourth longitudinal; second, third, and fourth longitudinals detached at their bases. Legs stout; femora greatly compressed; tibiæ with long spines; spurs long, pubescent; first two joints of tarsus of hind-legs with prickles on the under-surface.

I have only one species of this genus. It was taken in scrubby bush on the Port Hills in December.

*Cycloneura flava*, sp. nov. Plate XI., fig. 5.

Length of antennæ, ——— ?; size of body, 0·088 × 0·016; expanse of wing, 0·096 × 0·033.

Antennæ and palpi not seen. Front dark, but rather densely covered with grey hairs. Thorax dark-yellow, thinly clothed with short black and longer orange hairs situated on the lateral margins. Scutellum semicircular, ferruginous, with a few long setæ on the posterior margin. Pleuræ and metathorax dark-brown. Halteres with light-coloured stipes, and rather large black club. Abdomen depressed, broadest in the middle, dark-ferruginous, irregular patches being of a darker colour than the rest of the abdomen. Coxæ bright-yellow, with a row of hairs on the exterior margin; femora greatly compressed, bright-yellow, with yellow hairs; tibiæ longer than the coxæ, darker, with rows of short black hairs

and two ranges of spines, dark-ferruginous; spurs long, yellow; tarsi rather shorter than the tibiæ, yellow, with rows of short black hairs. Wings longer than the abdomen, yellow, but smoky at the tips, the darkest patch situated at the end of the second longitudinal vein. Neuration of the wings as described under the genus.

I have only one specimen of this species, which was taken on the Port Hills in December.

### Genus PARADOXA, nov. gen.

Head nearly round. Eyes large. Antennæ 2 + 14 jointed; joints shaped almost as in *Tetragoneura*. Palpi short, four-jointed; first and second joints very short, third longer and stouter, fourth the same length as third but much more slender. Thorax rather elongated. Abdomen compressed vertically, as broad as the thorax. Femora greatly compressed; tibiæ about as long as the femora, with a few slender black spines; spurs large, pubescent; first joint of tarsus the longest, others gradually decreasing in length. Wings longer than the abdomen. Auxiliary vein represented by a short rudiment; first longitudinal ending some distance beyond the middle of the anterior margin, joined to second longitudinal by marginal cross-vein situated near its apex; second longitudinal vein ending some distance before the apex of the wing; costa prolonged considerably beyond the tip of the second longitudinal vein, but not reaching the apex of the wing; third longitudinal vein with a long fork, slightly disconnected at its base; posterior branch also slightly disconnected at its base; anterior branch of fourth longitudinal reaching the margin, but disappearing before reaching the base of the wing; fifth longitudinal vein complete, reaching the margin, joined at a point about three-quarters of its length from the base by a strong vein as in *Cycloneura*, which probably represents the posterior branch of the fourth longitudinal vein.

I have only one species belonging to this distinct genus.

*Paradoxa fusca*, sp. nov. Plate XII., fig. 5.

Length of antennæ, 0·016; size of body, 0·096 × 0·010; expanse of wing, 0·092 × 0·016.

Antennæ 2 + 14 jointed; first joint of scapus short, nearly black; second joint cyathiform, ornamented with a few bristles; flagellum dark-brown, densely ciliated; joints broader than long, placed on very short pedicels tapering gradually to the apex; last joint has length more than twice its breadth and an obtuse apex. Palpi short, light-yellow; two basal joints short, third and fourth about equal in length, rather longer than the first and second put together.

Front black. Thorax strongly curved, black or dark-brown, rather sparsely covered with short black hairs, which are longer on the margins. Scutellum black, with a row of hairs on its posterior margin. Pleuræ and metathorax black. Abdomen black, but third and fourth segments dark-brown, sparsely covered with short black hairs. Legs rather short; coxæ smoky; femora compressed, yellow in the centre, but bordered with dark-brown; tibiæ rather longer than the femora, not slender, the two posterior pairs with a few moderately-long black spines, anterior tibiæ without spines; spurs rather stout, straw-coloured, and covered with a light pubescence. Wings brown, darker near the costa and in the central portion of the first submarginal cell. Inner marginal cell long, its apex being nearly directly above the apex of fork of third longitudinal vein; cross-vein situated near the end of first longitudinal vein; costal vein ending before the tip of the wing; second longitudinal vein joining it some distance before its tip. Surface of the wing microscopically pubescent.

I have only one specimen, taken at Lincoln College, in September.

### Genus EURYCERAS, gen. nov.

Head oval, not very deeply imbedded in the thorax. Eyes large, round, slightly emarginate on the inner side above. Palpi incurved, rather short; first and second joints about equal, short; third joint about double their length, cylindrical; fourth joint still longer, slightly clavate. Ocelli three, large, placed almost in a straight line on the broad front. Antennæ 2 + 14 jointed, about as long as the head and thorax together; joints of scapus much broader than long, cupuliform, setiferous above; flagellum compressed, broadest part in the middle, joints generally broader than long except at the apex, densely pubescent. Thorax highly arched, pubescent, without strong setæ on the lateral margins. Scutellum rather small, semicircular, hardly setiferous. Metathorax steep. Abdomen rather flattened, seven-segmented, narrow in front but broader posteriorly. Forceps of the male rather small, chelate. Legs rather slender; coxæ short but stout, hairy; femora slender, but posterior pair compressed, pubescent; fore tibiæ larger than the metatarsus but less than half the length of the whole tarsus, intermediate tibiæ rather shorter and posterior tibiæ longer than the tarsus, three ranges of small spines on fore and intermediate tibiæ and two ranges of longer spines on posterior tibiæ; spurs rather short; first not much longer than second joint of tarsus, a few small prickles on the under-side of tarsus. Wings rather pointed at the apex, and anal angle rather prominent; surface of wings distinctly hairy. Auxiliary vein

complete but short, subcostal cross-vein situated about halfway along it; first longitudinal joining costa more than two-thirds the length of the wing; second longitudinal joining the costa before the apex; costa slightly extended beyond the point of junction, but not reaching the apex of the wing; submarginal cross-vein about equal to basal portion of second longitudinal; petiole of third longitudinal rather short; apex of fork of fourth longitudinal just below origin of third longitudinal, branches divergent; fifth longitudinal strong but incomplete.

This genus is closely related to *Anaclinia*, Winn.

*Euryceras anaclinoides*, sp. nov. Plate XI., fig. 1; Plate XIII., figs. 14, 15.

Length of antennæ, 0·068; size of body, 0·132 × 0·034; expanse of wing, 0·154 × 0·060.

Antennæ 2 + 14 jointed; joints of scapus short, yellow, cyathiform, covered with short yellow cilia; joints of flagellum black, but densely covered with a yellow pubescence; fifth and sixth joints broadest, their breadth being half as much again as their length; terminal joint the longest, its length being about three times its breadth; succeeding joints gradually decreasing in length but increasing in breadth. Palpi very light yellow, incurved; first joint short; second joint rather long and broad, densely ciliated with light-yellow hairs; third and fourth joints much more slender, about equal in length, densely ciliated. Vertex black, rather hairy. Ocelli situated nearly in a straight line. Eyes emarginate, but not nearly meeting. Thorax light-yellow anteriorly but much darker posteriorly, becoming almost black in front of the scutellum; surface covered with short black hairs, the sides with a margin of long golden hairs. Scutellum dark-brown, with a fringe of black hairs. Metathorax almost black, the posterior portion with a few long yellow hairs. Pleuræ brown, with a few long hairs. Halteres with stout pedicels bearing an elongated pyriform club, light-yellow in colour, and covered with a fine pubescence. Abdomen black, first segment yellow except in centre of dorsal surface, where it is brown covered with long yellow hairs; abdomen broadening considerably posteriorly, the posterior portion of each segment brown, last segment with a yellow border covered all over with rather black hairs. Legs rather long; coxæ yellow, the outer surface of posterior coxa brown, a few stiff yellow hairs on each coxa; intermediate and posterior femora brown on the anterior side of the upper portion, and at the distal extremity, which is covered with black hairs, other parts of coxa yellow, covered with short yellow hairs; tibiæ of anterior and intermediate legs rather short, yellow,

but covered with black hairs and a few black spines; posterior tibiæ rather long and stout, with more numerous and longer spines; all tarsi black, owing to thick covering of black hairs; spurs yellow at the base, shading to brown at the tip. Wings slightly shaded with brown, and covered with black hairs. Costa and first and second longitudinal veins black, others light-brown; fifth longitudinal extending some distance beyond fork of fourth, but not reaching the margin.

I have only one specimen of this insect. It was taken in *Fagus* bush, at the base of Mount Torlesse, in March.

### Genus ANOMALA, nov. gen.

Head moderate, nearly round, but slightly prolonged posteriorly, situated rather deep in the thorax. Eyes ovate, entire. Ocelli two, or three: if only two present, one is situated in the margin of each of the compound eyes; if three, the third in the middle of the front. Palpi short, incurved, four-jointed; first joint short, moderately robust; second much longer; third and fourth more slender and about equally long. Antennæ cylindrical, tapering towards the apex, projecting forwards, arcuated, 2 + 14 jointed; first joint of scapus nearly cylindrical, second cupuliform, both joints setiferous on the sides and upper edge; flagellar joints cylindrical, with a short downy pubescence. Thorax highly arched. Scutellum semicircular. Abdomen rather flattened, broadest in the middle. Legs rather short; tibiæ spurred, and provided with lateral spines which are short on the anterior tibiæ, and long ones arranged in three ranges on the intermediate and two ranges on the posterior tibiæ. Wings with rounded apex and anal angle. Auxiliary vein joining the costa just before the origin of the third longitudinal vein; costal vein extending some distance beyond the tip of the second longitudinal vein; first longitudinal joins the costa before the branch of the third longitudinal vein; marginal cross-vein situated a little before the tip of the first longitudinal, which bends down and closely approaches the second longitudinal; anterior branch of third longitudinal reaching the margin just before the apex of the wing; apex of fork of fourth longitudinal situated just before the apex of fork of third longitudinal; anterior branch straight, posterior branch undulated; fifth longitudinal indistinct; subcostal cross-vein absent.

This genus is closely allied to *Leia*, *Ataleia*, *Acrodicrania*, and *Cœlosia*, but can be easily distinguished by the absence of the subcostal cross-vein, and by the fact that the third and fourth longitudinal veins are complete.

*Anomala guttata.* Plate XI., fig. 3; Plate XIII., figs. 16, 17.

*Mycetophila guttata,* Hutt.

Length of antennæ, 0·079; size of body, 0·174 × 0·044; expanse of wing, 0·165 × 0·066.

Antennæ 2 + 14 jointed; joints of scapus yellow, first much longer than the second, which is cyathiform, surface of both with a few stout short black hairs which are much longer on the edge of the second joint; first five or six joints of flagellum yellow, terminal joints nearly black, length usually about twice the breadth, all joints densely covered with short hairs having bright silvery reflections. Palpi prominent, rather large and thick, light-yellow, with a few short hairs. A black shining patch round each ocellus, but an orange area between them. Vertex dark-brown, with long black hairs on the margin. Thorax dark-yellow, surface with a few scattered hairs, which are long on the anterior and lateral margins; four longitudinal brown stripes, two short ones extending from the collare to the insertion of the wings, one on each side of the median line, but never confluent; the other two near the lateral margin, commencing farther back, and extending nearly to the scutellum, never confluent. Scutellum dark-brown anteriorly, light-yellow posteriorly, fringed with long black hairs. Metathorax and pleuræ dark-brown. Halteres with light-coloured rather slender pedicels bearing an oval club, light-yellow in colour. Abdomen broadest in the middle, covered with hairs giving golden reflection; anterior portion of each segment yellow, posterior and longer portions dark-brown. Legs rather short; coxæ light-yellow, with black hairs on anterior surface; femora brown at both ends but yellow in the centre; tibiæ rather stout, those of posterior and intermediate legs darkened at both extremities and covered with short hairs and bearing several spines of two sizes; anterior tibiæ only with shorter spines; tarsi light-yellow, but thickly clothed with dark hairs; spurs brown. Wings with brownish tinge, microscopically pubescent; one brown patch between apex of first longitudinal and costa; another patch at fork of second and third longitudinals, and a third on the inner side of posterior branch of fourth longitudinal; a more indistinct patch between anterior branch of fourth longitudinal and posterior branch of second longitudinal—*i.e.*, near the margin of first posterior cell. Second longitudinal joining costa not far before apex of wing; costa almost reaching the apex; apex of fork of third longitudinal much nearer the apex of wing than transverse vein, the latter situated half-way along the wing; fork of fourth longitudinal nearer base of wing than junction

between second and third longitudinals; branches reaching margin far apart. Size of brown patches varies considerably.

This is an excessively common insect throughout the colony. It may be taken throughout the year, but is more frequent in the spring months.

*Anomala minor*, sp. nov.

Length of antennæ, 0·066; size of body, 0·120 × 0·027; expanse of wing, 0·140 × 0·046.

Antennæ 2 + 14 jointed; joints of scapus dark-yellow, covered on the upper surface with stiff black hairs, one of which, situated on the anterior rim of the second joint, is larger than the two joints together. Palpi light-yellow. Vertex black, but covered rather thickly with long yellow hairs. Thorax dark-tawny to black; in the former case marks are present closely resembling those on the thorax of the last species; surface covered thickly with long yellow hairs. Scutellum black, with very short hairs on its posterior margin. Metathorax and pleuræ black. Halteres white; club pyriform, rather elongated. Abdomen black, covered with minute golden pubescence and thinly-scattered long golden hairs. Legs rather short; coxæ almost white, but darker at the distal extremity; femora dark-brown at both ends but very light in the middle, covered with long golden hairs; tibiæ rather stout, yellow, but darker at both extremities, covered with short black hairs and with two rows of long black spines; spurs light-yellow, with short black hairs; tarsi yellow, but densely covered with short black hairs. Wings with slight brownish tinge, microscopically pubescent; brown patches in same position but lighter, except the one situated in the first submarginal cell; all the apical portions of the wing shaded light-brown. Veins at the base light-yellow, but almost black at the extremity; first and second longitudinal veins do not approach so closely as in the last species; second longitudinal short; costa not nearly extending to tip of wing; apex of fork of third longitudinal situated almost below transverse vein; transverse vein nearer apex of wing than half-way; fork of fourth longitudinal almost directly below point of junction between second and third longitudinals; branches of fourth longitudinal not reaching margin, far apart.

Not so abundant as the preceding, but common at Christchurch and Wanganui.

## Genus APHELOMERA, Skuse.

Head small, round, the fore part flattened, situated deep in the thorax. Ocelli three, of almost equal size, arranged in a curved line high on the front. Eyes ovate, a little emargi-

nate above on the inner side. Palpi prominent, incurved, four-jointed; first and second joints somewhat robust, first joint small, second twice the length of the first, third rather longer than the first and second taken together and considerably more slender, fourth joint very slender, about equal in length to all the others taken together. Antennæ arcuated, projecting forward, longer than the head and thorax combined, very slender, 2 + 14 jointed; joints of the scapus of about equal size, cupuliform, both setiferous at the apex; flagellar joints cylindrical, with a short dense pubescence. Thorax oval, highly arched. Scutellum small, almost semicircular. Metathorax high, acclivous. Abdomen slender, cylindrical, six-segmented, with an anal joint almost as large as the sixth abdominal segment, and small forceps. Legs long, slender; femora not so robust as the coxæ, compressed; tibiæ spurred, and the intermediate and hind pairs each with two rows of lateral spines. Wings oblong-ovate, longer than the abdomen, rounded off at the base, microscopically pubescent. Costal vein extending far beyond the tip of the second longitudinal vein, stopping a little before the apex of the wing; auxiliary vein joining the costa a little before the marginal cross-vein; the humeral cross-vein very oblique; no subcostal cross-vein; first longitudinal vein joining the costa at a point three-fourths of the distance from the root of the wing to the tip of the costa; the marginal cross-vein situated very much before the middle of the first longitudinal vein, at a point about one-third the length of the latter; third longitudinal vein detached from the second longitudinal vein, starting in the wing-disc considerably beyond the marginal cross-vein, reaching the margin much below the apex of the wing, without any trace of an anterior branch; fourth longitudinal vein joining the margin before the tip of the first longitudinal vein joins the costa, the only trace of an anterior branch being an indistinct short piece of a vein quite detached from the fourth longitudinal vein, and joining the posterior margin a short distance in front of it; fifth longitudinal vein only rudimentary.

The only species of this genus hitherto described is from Sydney, so the genus would appear to be confined to Australasia.

*Aphelomera skusei*, n. sp. Plate XI., fig. 4.

Length of antennæ, 0·055; size of body, 0·073 × 0·018; expanse of wing, 0·066 × 0·030.

Joints of scapus orange, with a few black hairs; flagellum black, joints from three to five times longer than broad, covered all over with a fine pubescence. Palpi light-brown, darker at the tip. Thorax dark-brown or black, covered with short yellowish hairs and longer black hairs,

curved inwards. Scutellum black, bordered with long black hairs. Metathorax and pleuræ black, smooth. Halteres with stout yellow pedicel bearing an elongated black club densely covered with a black pubescence. Abdomen slender, black, densely clothed with black hairs. Coxæ rather stout, light-yellow; femora darker, more compressed, and thickly clothed with short yellow hairs; tibiæ light, but thickly covered with short black hairs; tibiæ of fore-legs half as long as tarsi, in posterior legs tibiæ nearly as long as tarsi; long spines on tibiæ and short ones on tarsi, black; spurs greyish-brown. Wings with a pale-brownish tint, veins brown; surface microscopically pubescent. A few long black hairs on first and second longitudinals; auxiliary distinct; fifth longitudinal rudimentary.

I have taken four specimens of this insect. It appears to be rather widely distributed. It is closely allied to *A. sydneyensis*, of Australia.

Genus ZYGOMYIA, Winn.

Tips of the costal and second longitudinal veins uniting far before the apex of the wing; auxiliary vein incomplete, bent anteriorly, gradually disappearing or only forming a tooth; apex of the inner marginal cell not situated beyond the base of the second submarginal cell; petiole of the fork of the third longitudinal vein very short; anterior branch of the fourth longitudinal vein wanting; fifth longitudinal vein incomplete; sixth longitudinal vein in most cases large.

I have placed the following species in this genus, though in some respects their alar venation varies from that described above: in particular, the fork of the third longitudinal vein has a moderately-long petiole, and the sixth longitudinal vein is wanting.

*Zygomyia flavicoxa*, sp. nov. Plate XI., fig. 6.

Length of antennæ, 0·041; size of body, 0·098 × 0·024; expanse of wing, 0·088 × 0·035.

Antennæ a little longer than head and thorax together; joints of scapus about equal in size, cyathiform, about as long as broad, light-brown large setæ on the anterior margin of second joint; flagellum dark-brown, rather compressed, the joints rather broader than long, densely covered with pubescence giving silvery reflections. Palpi light-yellow. Two lateral ocelli fairly large, central one small, situated in a marked depression. Front broad, black, with a few hairs giving yellowish reflections. Thorax with all the central portion black, humeral patches yellow, and lateral portions light-brown; everywhere covered with numerous hairs giving yellowish reflections. Metathorax and pleuræ black. Scutel-

lum black, with a few long hairs on the posterior margin. Abdomen black, narrow in front but broadening considerably posteriorly, hairs few and scattered. Forceps of male light-yellow. Halteres with a light-yellow pedicel; club large, pyriform, black. Legs not long; coxæ yellow, darkening towards the apex, where there are a few light-coloured setæ; trochanters light-yellow; femora rather compressed, yellow, but dark-brown or black at the apex, covered all over with black hairs, which are lengthened considerably near the end of the lateral margins; tarsi straw-coloured, with two ranges of long black spines; posterior spurs half the length of metatarsus, straw-coloured, but densely covered with short black hairs; tarsi with spines on the inner surface. Wings with a pale-yellow tinge; veins dark-brown, but lighter where they cross the white areas; costal margin of wing brown, the shading extending downwards at the marginal cross-vein; all the apical half of the wing shaded with brown, which is darker near the costal margin; a roundish white patch half in the second and half in the first submarginal cell. Tips of costal and second longitudinal veins uniting before the apex of the wing; fourth longitudinal strong; fifth longitudinal parallel to the third, ending about half-way down it; sixth longitudinal strong.

Common at Wanganui and Lincoln early in the spring.

*Zygomyia fusca*, sp. nov.

Length of antennæ, 0·049; size of body, 0·115 × 0·033; expanse of wing, 0·125 × 0·049.

Joints of scapus rather long, light-yellow, cyathiform, the first half as long again as the second; joints of flagellum rather compressed, dark-brown, those at the base about as long as broad, the apical ones with the length more than four times the breadth, thickly clothed with a pubescence giving silvery reflections. Palpi yellow. The central ocellus small, situated in rather a deep depression. Thorax dark-brown, bordered with orange anteriorly, and covered with black hairs. Scutellum dark-brown, with long hairs on the posterior margin. Metathorax and pleuræ dark-brown on upper portion, but black below. Halteres white; club oval, with a few black hairs. Abdomen black, with very few hairs except on the posterior margins of the segments; a cinereous band on the hind margin of every segment. Forceps of male dark-brown, and densely covered with black hairs. Legs moderate; coxæ almost white, but a small patch of brown and black hairs at the tip; trochanters dark; femora light straw-colour, with short black hairs which become setæ on the margins near the apex, rather dark at the base, compressed; tibiæ stout and, like the tarsi, closely resemble those of *Z. flavicoxa*.

Wings hyaline, with shaded patches similar to those on the wings of *Z. flavicoxa*, but much smaller; the white subapical patch longer, and extending almost from the costa to the posterior margin. Auxiliary vein bent slightly posteriorly; fifth longitudinal ending below the apex of the second submarginal cell; veins much stouter than in the last species.

Though the veining of the wings is almost identical with that in the last species, I have no doubt of the specific distinctness of the two types. The size of this species is much greater than that of the last. The halteres are white instead of black, the femora are not dark at the apex and are lighter in colour, the abdomen is ringed with cinereous; the wings have the dark patches smaller and much more closely defined.

### Genus BRACHYDICRANIA, Skuse.

Head roundish, compressed in the fore part, situated deep in the thorax; front broad, the anterior border prolonged as a small triangle, which reaches to the basal joints of the antennæ. Eyes longish-round. Ocelli two, large. Palpi prominent, incurved, four-jointed; first joint small, second longer, very robust; third joint subclavate, about one-third longer than the second; fourth joint very slender, about equal to all the others united. Antennæ projecting forward, somewhat arcuated, 2 + 14 jointed; first joint of scapus cyathiform, second much shorter than the first, cupuliform, both setiferous at the apex; flagellar joints cylindrical, somewhat compressed from the sides, with dense minute downy pubescence. Thorax ovate, highly arched, with a short pubescence, setiferous on the lateral and hind margins. Scutellum semicircular, setiferous. Metathorax steep. Abdomen slender, in the male with six, in the female with seven, segments, narrowed at the base, cylindrical, or a little compressed from the sides; anal joint of the male moderately large; female ovipositor very short, with two small lamellæ. Legs long, slender; intermediate and hind femora rather broadly compressed; tibiæ spurred, and having lateral spines, fore pair with one distinct range of very small size on the inner side and a few very small spines on the outer side, intermediate pair with a range of small spines on each side, hind pair with two ranges of longer spines on the outer side; metatarsus of the hind tarsi with some very minute prickles. Wings longer than the abdomen, oblong-oval, with moderately-rounded base, microscopically haired. Auxiliary vein very small, incomplete, directed towards the first longitudinal vein; costal vein not extending beyond the tip of the second longitudinal vein; marginal cross-vein situated about the middle of the first longitudinal vein and over the base of the second submarginal cell, the latter with a shorter petiole; tips of the third longi-

tudinal fork somewhat divergent; second posterior cell short, its base situated much beyond the base of the second submarginal cell; the branches of the fourth longitudinal fork divergent; fifth longitudinal vein long, incomplete; sixth longitudinal vein long.

This genus was established by Skuse for some Australian species. None have hitherto been described from any other country.

*Brachydicrania hiemalis*. Plate XI., fig. 2; Plate XIII., figs. 18, 19.

Length of antennæ, 0·055; size of body, 0·154 × 0·022; expanse of wing, 0·143 × 0·049.

Antennæ about as long as head and thorax; joints of scapus dark-yellow, setiferous; joints of flagellum rather longer than broad, difficult to distinguish near the base, but separated near the apex, dark-brown, but covered with a short dense pubescence giving a silvery reflection. Palpi long and slender; first, second, and third joints light-yellow; basal half of fourth joint light-yellow, apical half dark-brown. Front dark-brown, covered with rather short hairs. Thorax dark-brown, humeri and lateral margins dark-yellow, short yellow hairs and longer black ones covering its surface. Scutellum dark-brown, bordered with a few very long black hairs. Metathorax and pleuræ brown, smooth. Halteres with white pedicel; club smoky. Abdomen rather slender, covered sparingly with black hairs; first and second segments brown with yellow sides, and sometimes yellow on posterior margin; third segment dark-yellow, brown on centre of dorsal surface; remaining segments black. Legs long and slender; coxæ almost white, smoky towards the tip; femora very light yellow; tibiæ pale straw-colour, but covered with black hairs arranged in longitudinal lines, and two rows of long slender spines on intermediate and posterior tibiæ; tarsi nearly black from dense clothing of black hairs; those of anterior legs very long, shorter in intermediate, and about as long as tibiæ in posterior legs; spurs very long and slender, pale-brown. Wings microscopically pubescent, the pubescence being arranged in longitudinal lines; pellucid, with a very pale tint. Auxiliary very short; first longitudinal nearly parallel with costa; second longitudinal and anterior branch of third longitudinal slightly sinuate; marginal cross-vein situated beyond apex of second submarginal cell, about half-way along first longitudinal vein; neither branch of fourth longitudinal reaching the margin.

This insect was extremely common on window-panes and in low-lying bush in Wanganui in June and July. Closely allied to *B. pullicanda*, of Australia, but, I think, distinct.

## Genus MYCETOPHILA, Meig.

Head somewhat longish, round, compressed in the fore part, situated deep in the thorax; front broad, the anterior border elongated triangularly, which extends to the basal part of the antennæ. Eyes oval. Ocelli two, large. Palpi prominent, incurved, four-jointed; first joint small, the others equally so, or the last the longest. Antennæ projecting forward, arcuated, 2 + 14 jointed; the joints of the scapus cyathiform, setiferous at the apex; flagellar joints cylindrical, compressed from the side, with short downy pubescence. Thorax ovate, highly arched, with short pubescence, longer hair on the lateral margins, setiferous on the hind border. Scutellum semicircular, or a shortened triangle, setiferous on the border. Metathorax highly arched. Abdomen of the male with six segments, of the female with seven segments, more or less compressed from the sides, narrowing at the base; anal joint of the male generally small; ovipositor of the female with two lamellæ. Legs robust; femora compressed; tibiæ spurred, the fore pair with small spines on the outer side, the intermediate pair with two ranges of strong spines on the outer side and one range of stronger or weaker ones on the inner side; the hind tibiæ with two or three ranges of short spines on the outer side; metatarsi of the hind tarsi with fine prickles. Wings a little longer than the abdomen, longish-oval, the base rounded off or more or less obtusely-cuneiformly narrowed, microscopically pubescent. Auxiliary vein incomplete, bent anteriorly; costal vein not extending beyond the tip of the second longitudinal vein and not reaching the apex of the wing; marginal cross-vein situated at or somewhat beyond the middle of the first longitudinal vein, and over the base of the second submarginal cell, the latter with a short petiole or sessile; base of the somewhat-extended posterior cell situated before, under, or a little beyond the base of the second submarginal cell; the branches of the fourth longitudinal inclined towards one another at their tips; fifth longitudinal vein incomplete; rudimentary sixth longitudinal vein stout.

This is a large genus, including species that have been described from nearly every known country.

*Mycetophila sylvatica*, n. sp.

Length of antennæ, 0·104; size of body, 0·286 × 0·055; expanse of wing, 0·225 × 0·094.

Joints of scapus yellowish-brown, setose on the upper surface, first joint more than twice as long as the second; joints of flagellum light-brown; length four or five times the breadth, covered all over with a close pubescence giving grey

reflections. Palpi long, incurved; first joint nearly black, second joint long, light-brown, third joint similar to the second but more slender and shorter, fourth joint longest, orange-coloured. Front greyish-brown, setose, the hairs being black. Thorax dark-brown, thickly covered with short black hairs, with long curved black hairs on the margins. Scutellum black, with long black hairs on the margin. Metathorax and pleuræ black, the latter with long slender black hairs. Halteres with stout pedicels, very light yellow, but covered with short black hairs. Abdomen slender, dark-brown irregularly mottled with fulvous, covered everywhere with rather short black hairs. Legs rather long and slender; coxæ yellow at both ends, but the central portion is dark-brown, tip setose; femora dark-yellow, the tip and central portion shaded with brown, surface covered with short black hairs; tibiæ slender, straw-coloured, with longitudinal rows of black hairs, and spotted with brown spots, from which long spines arise; spurs dark-brown; tarsi long and slender, with horizontal rows of black hairs, but no spines. Wings with distinct brown tinge, but extreme tip yellow; a dark-brown patch at marginal cross-vein and apex of inner marginal cell; a very irregular band extending from the end of the first longitudinal to near the end of the second posterior cell; a shaded patch between these two marks and a shaded sub-apical area. Veins brown. Surface of wing microscopically pubescent, the hairs being arranged in oblique lines. Auxiliary not very short, slightly bent posteriorly and gradually disappearing; tip of costa and second longitudinal very near apex of the wing; fifth longitudinal extending to fork of fourth longitudinal; sixth longitudinal long, nearly reaching margin; inner marginal cell just lying over base of second submarginal cell, whose petiole is very short.

I found abundant specimens of this insect in one spot in a very damp gully on the bush-covered side of the Rimutaka Mountains, near the Summit Station.

*Mycetophila howletti*, sp. nov.

Length of antennæ, 0·132; size of body, 0·300 × 0·065; expanse of wing, 0·264 × 0·120.

Basal joint of scapus more than twice the length of the second, setæ black; length of joints of flagellum two or three times their breadth, the basal five or six joints with an orange band at both ends, but the central portion is dark-brown. Palpi dark-orange; first joint short, second stout, third more slender, bristly like the second, fourth strongly curved, broadening considerably at the apex, slightly bristly. Front yellowish-grey, covered with black hairs. Thorax reddish-yellow, but black on lateral margins above the wings, densely

covered with black hairs. Scutellum dark-brown, with strong hairs on its posterior margins. Metathorax yellow. Pleuræ dark-brown, covered with slender black hairs. Abdomen almost black, mottled with very dark brown; margins of some of the segments lighter. Legs robust; coxæ light-yellow, but brown on the posterior margin; femora rather expanded, greyish-yellow, with two black spots on the posterior side and a conspicuous black tip on the posterior legs; tibiæ dull-yellow, with a black tip covered with longitudinal rows of black hairs and spines of two sizes, the longer ones being orange-red; spurs long, orange-red in colour; tarsi darker than the tibiæ, several rows of fine spines on the inner side. Wings very broad, microscopically pubescent, with a deep-yellow tint, but the larger part coloured almost black; a dark patch surrounding marginal cross-vein, which extends downward and spreads out widely, covering all the posterior portion of the wing, but becoming lighter as the margin is approached; this becomes darker nearer the apex and spreads up again to the second longitudinal vein, but has an irregular outline, becoming very much narrower at second longitudinal and reaching costa at the end of first longitudinal, the apex being yellow. First and second longitudinals brown; the others very strong and black; petiole of second submarginal cell very short, the apex of the inner marginal cell lying over the base of the second posterior.

I have only one specimen of this fine insect. It was taken in bush on the Ruahine Mountains, in January.

*Mycetophila fagi*, n. sp.

Length of antennæ, 0·055; size of body, 0·148 × 0·034; expanse of wing, 0·127 × 0·055.

Antennæ slender; joints of scapus long, long black setæ on anterior portion of last joint; flagellum nearly cylindrical, brown, the basal portion of each joint being lighter than the apical portion, covered all over with short pubescence. Palpi light-yellow. Head yellow, dark near the two ocelli. Thorax yellow, without any markings, but ornamented with a few long and many short black hairs. Scutellum yellow, with long black bristles on the posterior margin. Metathorax and pleuræ dark-yellow. Pedicel of halteres nearly white; club light-yellow, pubescent. Abdomen dark-brown, the posterior portion of each segment light-yellow. Forceps of male brown, with black setæ. Legs rather short; coxæ pale-yellow, with a few black setæ; femora straw-coloured, with black hairs; tibiæ straw-coloured, with long black spines but no smaller ones, and a fringe at the distal end; spurs long, straw-coloured, but densely covered with black pubescence; tarsi rather stout, with short black spines

on the lower surface. Wings with yellow tinge. Veins all about equally distinct; costal vein ending at tip of second longitudinal just before apex of wing; apex of inner marginal cell and of fork of third and fourth longitudinal almost in same transverse line; fifth longitudinal not reaching fork of fourth.

This is a doubtful species, but I believe it to be distinct. I have four specimens, taken in *Fagus* bush, in March.

*Mycetophila variabilis*, sp. nov. Plate XII., fig. 3.

Length of antennæ, 0·090; size of body, 0·187 × 0·033; expanse of wing, 0·198 × 0·071.

Antennæ rather slender; first joint of scapus light-yellow with setæ on lower surface, second joint with setæ all round anterior border; length of each joint of flagellum more than twice the breadth, basal half of each joint yellow, apical half brown, last seven joints entirely brown, covered with short pubescence giving grey reflections. Palpi yellow, covered with black hairs. Front dark-yellow, with short black hairs and a row of long black bristles along the anterior and lateral margins. Thorax dark-yellow, with short and long hairs scattered over its surface; sometimes the thorax is marked with more or less distinct broad dark-brown or black longitudinal stripes, which in extreme forms cover the greater part of its surface. Scutellum varies from yellow to brown, and has four long black bristles situated on its posterior border. Metathorax and pleuræ brown, the latter rather hairy. Abdomen varies from brown to yellow, the posterior margin of each segment being usually far lighter in colour than the anterior portion. Halteres with short stout pedicels bearing rather large clubs, brown in colour, covered with a close short pubescence. Legs stout; coxæ light-yellow, with one or two small spots of brown on the sides; femora light-yellow, in the darker specimens they are conspicuously tipped with black; tibiæ straw-colour, often darker at the tips, with longitudinal rows of black hairs and spines of two sizes, the longer being long and stout; the longer spur almost as long as the metatarsus; joints of tarsus light-yellow, with numerous rows of black hairs and spines on the under-surface. Wings with distinct yellow tinge. Veins dull-yellow, all equally distinct; auxiliary vein short, but not terminating abruptly; second longitudinal uniting with costa some distance before the tip of the wing; often a small black patch at the end of each branch of the longitudinal veins; usually a distinct black patch around marginal cross-veins, also a small one at apex of second posterior cell; fifth longitudinal ending at or a little before apex of second posterior

cell, its distance from the fourth longitudinal differs considerably in different specimens.

This is an extremely common and variable insect. Several varieties seem to be well marked, and subsequent investigation may show that they belong to different species. For the present I have united them, as I am not yet satisfied that some of them belong to different species. The insect may be taken throughout the year, but is especially abundant during the summer months. I have obtained specimens at Wanganui and Lincoln, as well as at several intermediate localities.

*Mycetophila robusta*, sp. nov.

Length of antennæ, 0·121; size of body, 0·198 × 0·054; expanse of wing, 0·204 × 0·090.

Antennæ slender; joints of scapus not very stout, reddish-yellow, the basal joint setiferous on the lower surface, the upper joint all over the upper margin; flagellum with basal joint in length about four times its breadth, reddish-yellow, others with length about three times their breadth, reddish-yellow on the lower portion, dark-brown above, the yellow portion smaller and the brown portion larger in each succeeding joint as the apex is approached; all joints covered with short pubescence. Palpi reddish-yellow; second and third joints stout, covered with short black hairs; fourth joint very slender and rather longer, and not so densely covered with black hairs. Front reddish-yellow, the anterior margin and lateral margins fringed with stout black hairs. Thorax, scutellum, metathorax, and pleuræ reddish-yellow; thorax with rather short black hairs. Scutellum with four long black spines on posterior portion. Halteres short, reddish-yellow; clubs pyriform, with black pubescence. Abdomen reddish-yellow, darker on the upper surface, covered all over with rather short black hairs. Legs stout; coxæ bright-yellow, setiferous at the end; femora rather dilated, yellow, covered with short black hairs; tibiæ with longitudinal rows of short black hairs, two rows of very long spines and a few shorter ones; tarsi yellow, with longitudinal rows of black hairs and numerous black spines on the under-surface; spurs very long and stout. Wings with pronounced yellow tinge. Veins yellow; tip of costal uniting with tip of second longitudinal almost at the apex of the wing; fifth longitudinal not nearly reaching apex of second posterior cell; sixth longitudinal longer. Black spots on the wing absent or less pronounced than in the last species.

The three last species are very closely allied, and would perhaps be more properly classed as varieties of a single species. The chief distinction between them is their size, but this cannot be considered a specific character if specimens

intermediate between the extremes are found. I have included a large number of specimens, differing considerably in size as well as in markings on the wings and bodies, under *M. variabilis*, but intermediate specimens are very numerous, and undoubtedly link the extremes together sufficiently to justify their inclusion in the same species. Of the present species I have four specimens, taken in forest country on the flanks of the Ruahine Mountains, closely allied to *M. lineola*, Meig., of England.

*Mycetophila maculata*, sp. nov. Plate XII., fig. 2.

Length of antennæ, 0·049; size of body, 0·103 × 0·024; expanse of wing, 0·110 × 0·055.

Antennæ dark-brown, moderately slender; joints of scapus dark-yellow, first much longer than the second, setæ small; flagellum nearly cylindrical, joints at base much longer than broad, those near the apex about as long as broad, covered with dense pubescence, light near the base but darker near the apex. Palpi dark-yellow. Front dark-brown, with black hair. Thorax dark-brown, lighter on the front and lateral margins, one long spine on each side of the posterior margin. Scutellum dark-brown, with four long black spines on the posterior margin. Metathorax and pleuræ black. Halteres white; club moderate, covered with very fine white pubescence. Abdomen black, with a narrow white stripe on the posterior border of the second, third, fourth, and fifth segments; abdomen greatly compressed, and covered with black hairs. Legs rather slender; coxæ stout, dark-brown on the outer surface and on the tip; femora broad, greatly compressed, basal portion yellow, apical portion black, covered with short black hairs; tibiæ rather stout, with several longitudinal rows of black hairs, and two rows of long black spines; spurs long; tibiæ rather light-coloured, with rows of hairs and with spines on under-surface. Wings with yellowish tinge; brown spot extending from apex of second submarginal cell and origin of third longitudinal to costa; a brown band extending from apex of first longitudinal to the posterior margin, becoming gradually lighter as the posterior margin is approached; apex slightly shaded with brown, also a small area situated beneath the apex of second posterior cell.

This insect is abundant all through the summer. It is closely allied to *M. lunata*, Meig., of England.

## Brevicornu, nov. gen.

Head rather longer than broad. Eyes small, separated by a broad front. Antennæ very short; flagellum not three times as long as the scapus, ending in a sharp point. Ocelli

small. Thorax strongly curved. Abdomen compressed laterally, with six segments in the female. Legs moderately long, rather slender; femora compressed; tibiæ of anterior legs without spines, posterior and intermediate tibiæ with a few very weak spines; spurs rather long and slender; tarsi slender, first joint more than twice as long as any of the succeeding joints. Wings rather shorter than the abdomen, microscopically pubescent. Auxiliary vein short, ending in the costa; first longitudinal ending in the costa at a point more than two-thirds of the length of the wing; second longitudinal vein joining the tip of the costa before the apex of the wing; inner marginal cell rather lengthened, but its apex lies before the apex of the fork of the third longitudinal vein; inner marginal cell not quite closed, as marginal cross-vein is not perfect; petiole of third longitudinal vein not very short; fourth longitudinal vein with very acute fork, the apex of the second posterior cell lying some distance before the apex of the second submarginal cell; fifth longitudinal vein incomplete, ending just beyond the apex of the fork of the second posterior cell.

The character of the antennæ and of the tibiæ I think justify me in establishing a new genus for this species. I have, so far, specimens of but one species.

*Brevicornu flava*, sp. nov. Plate XII., fig. 4; Plate XIII., fig. 20.

Length of antennæ, 0·020; size of body, 0·100 × 0·021; expanse of wing, 0·088 × 0·033.

Antennæ short; joints of scapus bright-yellow with black hairs, about equal in length; joints of flagellum dark-brown, covered everywhere with a short dense pubescence giving silvery reflections; joints of about equal length, but the basal joints have a breadth about three times their length, while those near the apex are nearly as long as they are broad; terminal joint longer than broad, subconical. A small black patch round both ocelli. Front dark-brown, almost black. Vertex brownish-orange, with scattered hairs about the same colour. Palpi pale-yellow. Thorax dark-yellow, covered with long dark-brown hairs and shorter yellow hairs. Scutellum dark-yellow, fringed with long black hairs. Metathorax and pleuræ dark-yellow. Halteres yellow, small, covered with short pubescence. Abdomen greatly compressed, yellow, but darker on the posterior portion of each segment; terminal segment nearly black; all segments covered sparingly with short black hairs. Legs moderately long, rather slender; coxæ pale-yellow, with a few setæ near the end; femora yellow, rather robust, covered with short black hairs; tibiæ straw-colour, with longitudinal rows of short black

hairs and a few slender short spines; spurs nearly black, being covered with dense black pubescence; tarsi nearly black, with dense covering of short black hairs. Wings rather shorter than abdomen, pellucid, microscopically pubescent. Veins pale straw-colour; costa and first two longitudinals darker, owing to presence of row of black hairs; slight interruption in second longitudinal, just before marginal cross-vein; fork of third longitudinal long, branches nearly parallel for the greater part of their course; fork of fourth longitudinal long, apex situated just before origin of third longitudinal; posterior branch of third longitudinal disappears before reaching margin; posterior branch of fourth longitudinal slightly wavy, not quite reaching the margin; fifth longitudinal just reaching apex of fork of fourth; sixth longitudinal very rudimentary. Forceps of the male rather long and slender, bright-yellow in colour, and densely covered with rather stout short hairs. Abdomen darker than in the female. Lamellæ of the female slender, light at the base but dark-brown at the tip, covered with short soft hairs.

I have only two specimens of this insect, one male and one female, taken in *Fagus* bush at the foot of Mount Torlesse in March.

*Brevicornu fragilis*, sp. nov. Plate XII., fig. 1.

Length of antennæ, 0·014; size of body, 0·110 × 0·006; expanse of wing, 0·086 × 0·033.

Antennæ longer than in the last species; scapus yellow, both joints cyathiform, the first longer than the second, both with a fringe of black hairs; flagellum dark-brown, slender, about four times the length of the scapus, covered with a fine pubescence. Front black, covered with a greyish pubescence. Thorax greatly curved, black, but covered with greyish hairs; a few long black hairs on the lateral and posterior margins. Scutellum rather long, with a long black hair on each side of the posterior margin. Metathorax dark-brown. Pleuræ black. Halteres with a slender yellow pedicel ending in a white club. Abdomen greatly compressed, laterally black, and covered with hairs; the posterior margins of each segment dark-brown. Legs rather slender; coxæ yellow; femora rather compressed, yellow, with short black hairs; tibiæ rather long, with short spines on the intermediate and posterior pairs; spurs long, nearly black; tarsi long and slender. Wings yellowish. Basal portion of second longitudinal vein continuous; marginal cross-vein short; sixth longitudinal vein longer, but not reaching the margin.

I have several specimens, taken at Lincoln throughout the summer. The figure is rather incorrectly drawn.

## EXPLANATION OF PLATES.

### PLATE VIII.

Fig. 1. *Nervijuncta nigrescens*: *a*, palpus; *b*, antenna; *c*, end of abdomen.
Fig. 2. *Huttonia tridens*: *a*, palpus; *b*, end of abdomen; *c*, base of antenna.
Fig. 3. *Macrocera montana.*

### PLATE IX.

Fig. 1. *Macrocera scoparia.*
Fig. 2. *Bolitophila luminosa.*
Fig. 3. *Ceroplatus dendyi.*
Fig. 4. *Platyura ordinaria.*
Fig. 5. *Sciophila hirta.*

### PLATE X.

Fig. 1. *Sciophila fagi.*
Fig. 2. *Parvicellula triangula.*
Fig. 3. *Tetragoneura novæ zealandiæ.*
Fig. 4. *Cyrtoneura hudsoni.*
Fig. 5. *Aneura boletinoides.*

### PLATE XI.

Fig. 1. *Euryceras anaclinoides.*
Fig. 2. *Brachydicrania hiemalis.*
Fig. 3. *Anomala guttata.*
Fig. 4. *Aphelomera skusei.*
Fig. 5. *Cycloneura flava.*
Fig. 6. *Zygomyia flavicoxa.*

### PLATE XII.

Fig. 1. *Brevicornu fragilis.*
Fig. 2. *Mycetophila maculata.*
Fig. 3. *Mycetophila variabilis.*
Fig. 4. *Brevicornu flava.*
Fig. 5. *Paradoxa fusca.*

### PLATE XIII.

Fig. 1. Proboscis and palpi of *Cyrtoneura hudsoni.*
Fig. 2. Base of antenna of *Cyrtoneura hudsoni.*
Fig. 3. Antenna of *Ceroplatus leucoceras.*
Fig. 4. Scapus and basal joint of flagellum of antenna of *Bolitophila luminosa.*
Fig. 5. Scapus and basal joints of flagellum of *Platyura magna.*
Fig. 6. Palpus of *Platyura magna.*
Fig. 7. Forceps of male of *Platyura magna.*
Fig. 8. Palpus of *Parvicellula triangula.*
Fig. 9. Scapus and basal joints of flagellum of *Parvicellula triangula.*
Fig. 10. Palpus of *Tetragoneura nigra.*
Fig. 11. Scapus and basal joints of flagellum of *Tetragoneura nigra.*
Fig. 12. Palpus of *Aneura boletinoides.*
Fig. 13. Scapus and basal joints of flagellum of *Aneura boletinoides.*
Fig. 14. Palpus of *Euryceras anaclinoides.*
Fig. 15. Scapus and basal joints of flagellum of *Euryceras anaclinoides.*
Fig. 16. Palpus of *Anomala guttata.*
17. Scapus and basal joints of flagellum of *Anomala guttata.*
18. Palpus of *Brachydicrania hiemalis.*
19. Scapus and basal joints of flagellum of *Brachydicrania hiemalis.*
20. Scapus and basal joints of flagellum of *Brevicornu flava.*

# Art. XXVI.—*New Zealand Diptera: No. 3.*—Simulidæ.

By P. Marshall, M.A.

[*Read before the Philosophical Institute of Canterbury, 6th November, 1895.*]

Plate XIV.

## Family SIMULIDÆ.

This is quite a small family of flies, but has an extremely wide geographical distribution, being found in nearly all temperate countries north and south of the equator. The popular name for the insects belonging to this family is "sandflies" or "black-flies," and wherever they occur they are regarded as one of the worst insect-pests, on account of the great local irritation produced by the bite of the female. Three insects are recorded by Walker common in England, while many other species have been described from the European Continent and North America. Mr. Skuse has described two species in his Australian Diptera, but he considers them rather uncommon insects, and says that the majority of the insects known by the name of "sandfly" in Australia belong to the genus *Ceratopogon* of the family *Chironomidæ*. In New Zealand, so far as I am aware, no insects belonging to the *Chironomidæ* molest the peace of man or any other animals. The "sandfly" that is so common throughout the colony is a species belonging to the *Simulidæ*. The family contains but a single genus, but its characters are so peculiar and so constant that there can be no doubt that this genus is rightly excluded from all the larger families. It is undoubtedly more closely related to the *Bibionidæ* than to any of the other families. A New Zealand species was described by Schiner in 1868 under the name of *Simulia australiensis*. Though the description is somewhat meagre, I have no hesitation in assigning all the species that I have collected from three different localities to this species. I have no doubt that future research will reveal the presence of other species, but, as all my specimens show no variation except in size, I think they all belong to this species, which must have a very wide range in the colony.

Mr. Hudson, in his "Handbook of New Zealand Entomology," gives figures illustrating the three stages in the metamorphosis of this insect, and adds some valuable notes on its habits. As in other species, the larvæ are aquatic. They are rather broad maggots, with suckers at both extremities of the body, by means of which they crawl about like a leech or a grameter caterpillar on the plants growing in the

clear running streams that they always inhabit. It appears to be carnivorous in the larval state, living on various small crustaceans and rotifers that abound in these streams. Before pupating the larva fixes itself by glutinous threads to the underside of a leaf. From the anterior part of the body two long-branched filaments project, which are stated by Hudson to have a respiratory function. A cocoon is formed before pupation of membranous or gelatinous material, which is afterwards eaten almost entirely. The pupa hatches into the imago beneath the surface of the water.

### Genus SIMULIUM, Latreille.

Body small, gibbose, with a tomentum. Head small. Palpi four-jointed; first joint small, second and third longer, fourth long and composed of numerous small annuli, longer in the female than in the male. Antennæ eleven-jointed, narrowed to the tip, a little longer than the head; first and second joints remotely connected, remainder closely connected, transverse, end joint conical. Wings large; first, second, and third dark, remainder of the veins pale. Legs stout, compressed, unarmed; hind metatarsus incrassate in the male, lengthened, in the female hardly incrassate; male's generally black, female's cinereous. Eyes contiguous in the male, remote in the female. Labrum in female lanceolate; labium linear, bidentate at tip. Lingua very long, divided, apical part hairy on the outer surface. Also the antennæ are more remote than in the male.

The above is the fullest diagnosis in any of the works at my disposal. As the genus is such an old-established one I hesitate to add any characters from my own specimens. As in *S. furiosum* (Skuse), from Australia, our species has antennæ with 2 + 8 joints.

**Simulium australiense** (Schiner, "Reise der Novara," Dipt. ii., p. 15).

Blackish-brown, thorax dusted lighter; yellow round the corners of the shoulders; base of femora, tibiæ, and tarsi yellowish. Wings hyaline; costal vein intense black, not nearly reaching the apex of the wing, the other veins brownish; discoidal vein thick as far as the cross-vein, then very faint, the forks with a short petiole; postical and anal veins faint.

In the above description the discoidal vein is the third longitudinal, postical and anal veins are the fourth and fifth longitudinal veins.

This species is abundant on the banks of streams and lakes throughout the colony from sea-level to 3,000ft.

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EXPLANATION OF PLATE XIV.

Fig. 1. *Simulium australiense*. Female.
Fig. 2. Larva.
Fig. 3. Pupa.

## Art. XXVII.—*On* Dodonidia helmsi, *Fereday*.

By P. Marshall, M.A.

[*Read before the Philosophical Institute of Canterbury, 1st May, 1895.*]

Plate XV.

This species was added to the list of New Zealand butterflies by Mr. R. W. Fereday in 1882, in which year a description of the butterfly was written by him, drawn from a single specimen captured by Mr. Helms, of Westport, at an altitude of 1,500ft.

It has been my good fortune during the past summer to obtain eight good specimens of the insect; they were all obtained in the North Island, within a few miles of Wanganui. Seeing the great rarity of the butterfly, a few remarks on its habits may be worth recording. All the specimens were captured in small bush-gullies, the sides of which are partially cleared of the light bush that formerly covered them. In the upper parts of these gullies the stream at the bottom has formed a small gorge, and, as there is a steep fall, it rushes over small boulders and waterfalls. About half a mile from the head of the gully the fall becomes much less steep, and the bottom is broad and flat, the floor consisting of material brought down by the stream from the upper part of its course. Owing to the very small incline in this part of the gully the water flows sluggishly and spreads well over the flat bottom, forming a well-defined swamp, in which ordinary swamp-plants are found, such as *Typha angustifolia*, *Carex virgata*, *Cyperus ustulatus*, *Arundo conspicua*, and now and then a bush of *Veronica salicifolia*. It was in this part of the gully that the insects were found flapping lazily over the swamp-plants, and now and then alighting on leaves of shrubby trees that everywhere fringe the valley-bottom. It was particularly noticeable that the insects nearly always settled on the underside of the leaves of *Brachyglottis repanda* or *Fuchsia excorticata*, where the bright silver streaks on the under-surface of their secondaries so harmonized with the white surface of the underside of the leaf as to afford them abundant protection. The insects fed upon the honey in the flowers of the *Veronica* shrubs on which some of our specimens were captured. In three valleys of the nature above described these insects were found. One of these was close to Wanganui, and the other two at Kai-iwi, about eight miles in a direct line from the other locality. Though I have frequently visited these gullies

in previous summers whilst making botanical and entomological collections, I have never previously seen any specimens of this butterfly. Mr. Drew, curator, Wanganui Museum, assures me that, though he has often shot over these gullies, he has never seen any specimens of the butterfly.

We were, unfortunately, unable to find any larvæ or pupæ of the insect, but from the way the imago hovers over *Brachyglottis repanda* and *Fuchsia excorticata* it would seem probable that the larvæ feed on the foliage of one of these trees.

The occurrence of this butterfly suddenly, and in considerable numbers, seems to me a good instance of the sudden sporadic increase of butterflies about which so much speculation has been indulged in and so little is really known. In 1894 the usually rare *Danais archippus* became abundant in Wanganui, breeding in hundreds on plants of a species of *Gomphocarpus*; but, though the same plants have been kept in the same place in gardens, and numerous others have been sown, the insect did not appear last summer. The only cause one can imagine to have effect in this peculiar circumstance is the variation in climate and temperature from year to year. It is possible that some peculiar and unusual conditions of temperature or other meteorological variations are necessary for its full development in any summer.

Four of the specimens caught have been kept by my brother and myself in private collections; two have been placed in the Wanganui Museum, and two in the Canterbury Museum. The type-specimen described by Mr. Fereday is also in the Canterbury Museum. For a full description of the imago I refer to Mr. Fereday's article, "Transactions of the New Zealand Institute," vol. xv., p. 193.

In his description of the butterfly Mr. Fereday places a note of interrogation after the genus, subsequently remarking that, as he could not obtain the necessary books of reference, he was unable to determine the genus. The specimen was afterwards sent to England, and placed in the genus *Dodonidia*; but I have been unable to find the characters of this genus in any of the reference works at my disposal. It appears to be closely allied to the genus *Dodona*, which contains a few Indian species. In that case it would belong to the family *Erycinnidæ*, and not to the *Nymphalidæ*.

## EXPLANATION OF PLATE XV.

Fig. 1. *Dodonidia helmsi*, upper side.
Fig. 2. *Dodonidia helmsi*, under side.
Fig. 3. Venation of primary.
Fig. 4. Venation of secondary.

Art. XXVIII.—*Notes on some New Zealand Fishes, with Description of a New Species.*

By Captain F. W. Hutton, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 5th November, 1895.*]

**Plectropoma huntii**, Hector.

A specimen of this fish has been sent to the Canterbury Museum by Mr. Joshua Rutland, who obtained it from Queen Charlotte Sound. He says it is very rare, and that it lives in holes among rocks, feeding on shrimps. Sometimes it comes to the surface of the water and lies on its side for a considerable time. The fin formula differs slightly from that given by Sir James Hector of the specimen from the Chatham Islands. It is as follows:—

B. 7; D. $\frac{10}{18}$; A. $\frac{3}{7}$; L. lat. 46.

Total length, 8½in. There are villiform teeth on the jaws, palatines, and vomer, but none on the tongue.

**Chironemus spectabilis**, Hutton (*Chilodactylus*).

This species has teeth on the vomer, and should therefore be placed in *Chironemus*.

**Agriopus peruvianus**, Cuv. and Val.

Distinguished by having a small spine before each orbit. There are two specimens in the Museum collection, from Banks Peninsula.

**Trachyichthys traillii**, Hutton.

This species is figured in "Challenger" Reports, vol. xxii., pl. 55, fig. A.

**Seriolella punctata**, Forster; Descript. Anim., p. 140 (*Gasterosteus*); *Seriolella bilineata*, Hutton.

I have no doubt but that this is the long-lost fish of Forster. The mistake is due to the peculiar genus into which Forster put his fish, and from the absence in the colony of any copy of his drawing.

**Evistius huttonii**, Günther (*Platystethus*).

The new generic name is given by Dr. Theodore Gill for *Platystethus*, which is preoccupied.

**Cubiceps gracilis**, Lowe; Günther, "'Challenger' Pelagic Fishes," pl. ii., fig. A.

A specimen in the Museum was obtained in the Christchurch market in June, 1893.

**Cybium guttatum**, Bloch (?); Day's "Fishes of India," pl. lvi., fig. 4.

A damaged specimen of a *Cybium*, probably *C. guttatum*, was obtained at the Chatham Islands by Major Gascoyne, and presented to the Museum in April, 1894.

**Echeneis remora**, Linne.

There is a specimen in the Museum collection labelled "Wellington Harbour."

**Kathetostoma giganteum**, Haast.

In my list of New Zealand fishes (Trans. N.Z. Inst., vol. xxii., p. 279) this is by accident given as a synonym of *Anema monopterygium* (Bloch), whereas it should have been placed with the next species on the list—*K. læve* (Bloch). Haast's type, however, has no humeral spines, and may possibly be distinct.

**Kathetostoma fluviatile**, Hutton.

There are specimens in the Museum from the Rangitata River, forty miles from its mouth, and also from Dunedin; so that it inhabits the sea as well as the rivers. It has the same mesial occipital bony plate as *K. maculatus* (Forster), to which it is closely allied; but it has no scales on the sides of the tail; the humeral spines are short and obtuse, and the granulations on the opercular and cranial bones are not quite so coarse. The colouration is also slightly different; but the two species are so much alike that they are always considered to be the same by fishermen.

**Parapercis gilliesii**, Hutton.

A specimen which was obtained in the Christchurch market on the 27th June, 1893, is in the collection. It agrees closely with the description of the type. The name *Parapercis* has been given by Dr. Theodore Gill, as *Percis* is preoccupied.

**Eleotris radiata**, Quoy and Gaimard.

I have received specimens from the Chatham Islands, collected by Major Gascoyne.

**Eleotris gobioides**, Cuvier and Val.

I have received specimens from the Chatham Islands, collected by Major Gascoyne.

**Tripterygium dorsale**, Clarke.

There is a specimen in the Museum, from Sumner.

**Tripterygium robustum**, Clarke.

There is a specimen in the Museum, locality unknown.

**Acanthoclinus taumaka**, Clarke.

There is a specimen in the Museum, from Banks Peninsula.

**Crepidogaster simus**, sp. nov.

D. 7; A. 7. Snout depressed, rounded, not produced, its length not quite twice the diameter of the eye, or about equal to the width of the interorbital space. Distance from the end of the dorsal, or anal, to the caudal very short, about one-fifth of the length of the caudal, or one-third of the least depth of the tail. Ventrals united to the pectorals by a membrane. Ventral sucker broader than long. Colouration uniform. Lyttelton Harbour and Chatham Islands.

Differs from *C. hectoris* in having the dorsal and anal fins close to the caudal. The type-specimen was presented by Mr. F. W. Tregear, on the 27th December, 1892.

**Labrichthys roseipunctata**, Hutton; Trans. N.Z. Inst., vol. xii., p. 455.

I omitted this species from my list of New Zealand fishes, 1889.

**Labrichthys cincta**, Hutton.

There is a specimen in the Museum collection, obtained in the Christchurch market.

**Physiculus bacchus**, Foster.

*Lotella bacchus* and *L. rhacinus* both belong to *Physiculus*, distinguished by the flat ventral fins.

**Motella novæ-zealandiæ**, Hector.

Specimens are in the Museum, from Sumner.

**Anchenoceros punctatus**, Hutton.

A specimen obtained in the Christchurch market, 22nd May, 1895, is in the collection.

**Hyplolycodes haastii**, Hector.

I think that this genus should be placed in the *Ophidiidæ*, on account of its wide gill-openings. The ventrals are jugular, consist of six rays, and reach to the vent when laid back.

GENUS **Galaxias**, Cuvier.

I divide the New Zealand species as follows:—

A.—*Tail truncated or slightly rounded.*

1. Pectorals more than half the distance to the ventrals. Ventrals much more than half the distance to the anal.

*G. alepidotus*, Forster.

Length (without caudal) about four and a half times the height; least depth of the tail more than the distance between the dorsal and caudal fins. Blackish-brown, with scattered pale spots or streaks.

Arthur River, Milford Sound; Chatham Islands.

Var. *brocchus*, Richardson.

The pale streaks forming rings.

Arthur River, Milford Sound; Heathcote River, Christchurch.

*G. fasciatus*, Gray = *G. reticulatus*, Rich.

Length (without caudal) five times the height; least depth of the tail equal to the distance between dorsal and caudal fins. Brown, with light-coloured transverse bands.

North Island of New Zealand and Chatham Islands.

2. Pectorals less than half the distance to the ventrals. Ventrals about half the distance to the anal.

*G. brevipinnis*, Günther.

Length (without caudal) about seven and a half times the height. Brownish-olive, with dark-brown reticulating bands.

Otira River; Lake Coleridge.

Var. *grandis*, Haast.

Dark-brown above, either uniform or with pale spots and streaks.

Rivers of the Canterbury Plains.

B.—*Caudal emarginate, pectorals less than half the distance to the ventrals.*

*G. lynx*, nomen novus. *G. olidus*, Hutton, not of Günther.

Ventrals more than half the distance to the anal. Length of the body about six and a half times the height. Yellowish- or brownish-grey, with scattered small round black spots.

Lake Coleridge; Lake Wakatipu.

*G. attenuatus*, Jennings.

Ventrals less than half the distance to the anal. Length of the body more than eight times the

height. Greenish-yellow, more or less spotted with brown, each spot being composed of minute dots.

Both Islands of New Zealand, and Chatham Islands.

**Retropinna richardsoni**, Gill.

Specimens are in the Museum, from the Chatham Islands.

**Photichthys argenteus**, Hutton.

This species has been figured by Dr. Günther in the Report on the Deep-sea Fishes of the "Challenger," pl. xlv., fig. A.

**Argentina elongata**, Hutton.

This species is considered distinct by Dr. Günther, and is figured by him in the Report on the Deep-sea Fishes of the "Challenger," pl. lv., fig. B.

**Clupea sagax**, Jenyns.

A specimen of this fish was procured in the Christchurch market on the 22nd May, 1895. The fishmonger said he had never seen one before.

**Anguilla aucklandii**, Richardson.

Specimens have been sent me from the Chatham Islands. I now think that what I called *A. latirostris* is only the young of *A. aucklandii*.

**Anguilla australis**, Richardson.

Specimens have been sent me by Major Gascoyne from the Chatham Islands.

**Ophichthys novæ-zealandiæ**, Hector.

This species differs from *O. serpens* in having only one row of teeth on the maxillary and intermaxillary bones.

**Centrina bruniensis**, Ogilby.

This is not *C. salviana*, as I supposed. The differences have been pointed out by Mr. Ogilby in the "Records of the Australian Museum," No. 11, p. 62 (1893).

**Trygon brevicaudatus**, Hutton.

This may be the same as *T. margarita*, Günther; but that species comes from West Africa, and in the description no mention is made of any ossification on the tail.

## ART. XXIX.—*Further Contributions to the Molluscan Fauna of New Zealand.*

By HENRY SUTER.

Communicated by Captain Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 5th November, 1895.*]

IN volumes xxiv. and xxv. of these Transactions I published lists of the land and fresh-water shells found at various places in this colony. More material having accumulated in my collection, I now wish to publish some additional lists, thus helping to enlarge the knowledge of the geographical distribution of some of our Mollusca, which is still very far from satisfactory. Most of our land-shells being minute or small, and living concealed in the bush under logs, stones, dead leaves, bark, &c., during day-time, it is not astonishing that much remains to be done in the way of collecting, and that new forms are still turning up when a careful search for shells is made.

### I.—*Mount Wellington Lava-fields, Auckland.*

In volume xxiv. of the Transactions, pp. 277, 278, a list of shells from this locality was given, collected by Mr. C. Musson. Last summer I had a couple of hours collecting on these lava-fields, and found the following additional species:—

*Flammulina* (*s. str.*) *pilsbryi*, Suter.
" (*Therasia*) *celinde*, Gray.
" " *tamora*, Hutton.
*Endodonta* (*Thaumatodon*) *timandra*, Hutton.*
" (*Ptychodon*) *hunuaensis*, Suter.
" (*Charopa*) *buccinella*, Reeve.†
" " *anguiculus*, Reeve.
" " *corniculum*, Rve., var. *maculata*, Sut.
" " " " f. *albina*.
*Laoma* (*Phrixgnathus*) *pumila*, Hutton.
" " *ariel*, Hutton.
" " *allochroida*, Suter, var. *lateumbilicata*, Suter.
" " *moellendorffi*, sp. nov.

* Erroneously "*varicosa*, Pfr." in former list.
† = "*sylvia*, Hutton," in former list.

### II.—*Nikau Bush, Titirangi, near Auckland.*

About one hour of collecting produced the following shells:—

*Lagochilus hedleyi*, Suter.
*Realia egea*, Gray.
" *carinella*, Pfr.
*Flammulina* (*Therasia*) *celinde*, Gray.
" (*Carthæa*) *kivi*, Gray.
" (*Phenacohelix*) *pilula*, Reeve.
" (*Allodiscus*) *dimorpha*, Pfr.
" " *planulata*, Hutton.
*Endodonta* (*Thaumatodon*) *timandra*, Hutton.
" (*Ptychodon*) *hunuaensis*, Suter.
" (*Charopa*) *coma*, Gray.
" " *infecta*, Reeve.
" " *bianca*, Hutton.
" " *titirangiensis*, sp. nov.
*Laoma* (*s. str*) *pœcilosticta*, Pfr.
" (*Phrixgnathus*) *glabriuscula*, Pfr.
" " *ariel*, Hutton.

### III.—*Tarukenga, near Rotorua.*

The following shells were collected and kindly given to me by Captain T. Broun:—

*Realia carinella*, Pfr.
*Flammulina* (*s. str.*) *zebra*, Le Guillou.
" " *crebriflammis*, Pfr.
" " *pilsbryi*, Suter.
" (*Therasia*) *tamora*, Hutton.
" (*Phenacohelix*) *pilula*, Reeve.
" (*Thalassohelix*) *ziczac*, Gould.
*Endodonta* (*Ptychodon*) *pseudoleïoda*, Suter.
" (*Charopa*) *caput-spinulæ*, Reeve.
" " *roseveari*, sp. nov.
*Laoma* (*s. str.*) *leimonias*, Gray.
" " *marina*, Hutton.
" (*Phrixgnathus*) *mariæ*, Gray.
" " *conella*, Pfr.
" " *phrynia*, Hutton.
" " *allochroidus*, Suter, var. *lateumbilicata*, Suter.
*Rhenea coresia*, Gray.

### IV.—*Heretaunga, Hawke's Bay.*

I am indebted to Mr. A. Brooks for the following shells:—

*Flammulina* (*s. str.*) *compressivoluta*, Reeve.
" (*Phenacohelix*) *pilula*, Reeve.
" (*Suteria*) *ide*, Gray.
*Endodonta* (*Ptychodon*) *pseudoleioda*, Suter.
" (*Charopa*) *coma*, Gray.
" " *infecta*, Reeve.
" " *biconcava*, Pfr.
" " *bianca*, Hutton.
" " *tapirina*, Hutton.
" " *colensoi*, Suter.
*Laoma* (*Phrixgnathus*) *mariæ*, Gray.
" " *conella*, Pfr.

V.—*Dannevirke, Waipawa.*

The same collector :—

*Athoracophorus bitentaculatus*, Q. and G. (=*maculatus*, Collinge).
*Flammulina* (*Thalassohelix*) *propinqua*, Hutton.
" (*Phacussa*) *hypopolia*, Pfr.
" (*Allodiscus*) *dimorpha*, Pfr.
" " *adriana*, Hutton.
" " *planulata*, Hutton.
*Endodonta* (*Ptychodon*) *hunuaensis*, Suter.
" (*Charopa*) *coma*, Gray.
" " " " var. *globosa*, Suter.
" " *corniculum*, Reeve.
" " *lucetta*, Hutton.
" " *anguiculus*, Rve., var. *montivaga*, Sut.
" " *tapirina*, Hutton.
" " *bianca*, Hutton.
" (*Phenacharopa*) *novoseelandica*, Pfr.
*Laoma* (*Phrixgnathus*) *ariel*, Hutton.

VI.—*Environs of Pelorus Sound.*

Mr. Joseph McMahon, a most enthusiastic collector, kindly sent me a large number of shells, consisting of,—

*Melanopsis trifasciata*, Gray.
*Potamopyrgus cumingiana*, Fischer.
" *corolla*, Gould.
*Lagochilus lignarium*, Pfr.
*Hydrocena purchasi*, Pfr.
*Bullinus variabilis*, Gray.
*Athoracophorus* (*Konophora*) *marmoreus*, Hutton.
" (*Pseudaneitea*) *papillatus*, Hutton.
" " " var. *nigricans*.
" " " var. *fasciata*.

*Flammulina* (*s. str.*) *zebra*, Le Guillou.
" " *crebriflammis*, Pfr.
" " *perdita*, Hutton.
" (*Phacussa*) *hypopolia*, Pfr.
" (*Therasia*) *traversi*, Smith.
" (*Pyrrha*) *cressida*, Hutton.
" (*Phenacohelix*) *pilula*, Reeve.
" (*Allodiscus*) *tullia*, Gray.
" " *planulata*, Hutton.
" (*Suteria*) *ide*, Gray.
" (*Thalassohelix*) *zelandiæ*, Gray, var. *antipoda*, H. and J.
*Endodonta* (*Thaumatodon*) *jessica*, Hutton.
" " *timandra*, Hutton.
" (*Ptychodon*) *hectori*, Suter.
" " *pseudoleioda*, Suter.
" " *microundulata*, Suter.
" " *wairarapa*, Suter.
" " *hunuaensis*, Suter.
" (*Charopa*) *coma*, Gray.
" " *buccinella*, Reeve.
" " *anguiculus*, Reeve.
" " *infecta*, Reeve.
" " " " var. *irregularis*, Sut.
" " *bianca*, Hutton.
" " " " var. *montana*, Suter.
" " *tapirina*, Hutton.
" " " " f. *albina*.
" " *lucetta*, Hutton.
" " *caput-spinulæ*, Reeve.
" " *subantialba*, Suter.
*Laoma* (*s. str.*) *marina*, Hutton.
" (*Phrixgnathus*) *celia*, Hutton.
" " *glabriuscula*, Pfr.
" " *regularis*, Pfr.
" " *spiralis*, sp. nov.
*Otoconcha dimidiata*, Pfr.
*Rhytida meesoni*, Suter.
*Unio menziesii*, Gray.
*Pisidium novæ-zelandiæ*, Prime.

VII.—*Springburn, Mount Somers.*

Professor A. Dendy collected the following species:—
*Athoracophorus* (*Pseudaneitea*) *dendyi*, sp. nov.
*Flammulina* (*Therasia*) *thaisa*, Hutton.
" (*Allodiscus*) *planulata*, Hutton.
" " *adriana*, Hutton.
" (*Thalassohelix*) *igniflua*, Reeve.

*Endodonta* (*Charopa*) *coma*, Gray.
" " *anguiculus*, Rve., var. *montivaga*, Sut.
" " *sterkiana*, Suter.
" (*Æschrodomus*) *barbatula*, Reeve.

VIII.—*Toitoi, Fortrose, Southland.*

To Miss J. G. Rich I am indebted for the following Mollusca:—

*Flammulina* (*Phacussa*) *hypopolia*, Pfr.
" (*Phenacohelix*) *chordata*, Pfr.
" (*Allodiscus*) *planulata*, Hutton.
*Endodonta* (*Charopa*) *tapirina*, Hutton.
" " *anguiculus*, Rve., var. *montivaga*, Sut.
" " *sterkiana*, Suter, f. *major*.
" " *moussoni*, Suter.
" (*Æschrodomus*) *stipulata*, Reeve.
*Laoma* (*Phrixgnathus*) *celia*, Hutton.

ADDITIONS TO THE LIST OF INTRODUCED MOLLUSCA.

*Limnæa auricularia*, L. Wanganui (R. Murdoch).
*Aneitea graeffei*, Humbert. Port Chalmers (Dr. Chilton); Collingwood (J. Dall).
*Cionella lubrica*, Müller. Auckland (Wright; H. S.).
*Vallonia excentrica*, Sterki. Auckland.
This shell was mentioned in my former list as *V. pulchella*, Müller. Since then Dr. Sterki has published a study on the genus *Vallonia*, and described the n. sp. *excentrica*, with which our shell perfectly agrees. It has very likely been introduced from England.
*Hyalinia alliaria*, Miller, I found in a paddock at Henderson, near Auckland.

ART. XXX.—*On a New Species of* Deinacrida *or Forest-cricket from Nelson.*

By Sir WALTER L. BULLER, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 16th October, 1895.*]

I HAVE the pleasure of exhibiting this evening a perfectly new species of that interesting group of orthopterous insects known as Wetas or Tree-crickets. For this very distinct form I am indebted to Mr. J. Brough, of Nelson, who met with it on the high wooded lands of the interior. As will be seen at a

glance, it is intermediate in size between the giant form, *Deinacrida heteracantha*, and *D. megacephala*, described and figured by me in vol. iii. of our Transactions. I exhibit specimens of both these forms for comparison with the new one, which I propose to name—

**Deinacrida broughi**, sp. nov.

*Female.*—Body long and rounded, the entire surface, both upper and lower, being polished or shining. General colour pale reddish-brown, darker on the vertex, paler on the antennæ and on the joints of the limbs, and changing to blackish-brown on the face, edges of the thoracic shield, sides of abdomen, hind tibiæ, and ovipositor. Head large, with a prominent or rounded vertex, altogether free from punctures; eyes large, round, and perfectly black; thoracic shield patchy-looking, but also free from punctures. Of the ten dorsal segments behind it, the two first are broad and squarish, the rest much narrower, even, and with clean-cut edges. Limbs more slender in proportion to the size of the body than in *Deinacrida heteracantha*. Labrum prominent; labial and maxillary palpi clavate at the tips. The cerci, which are yellowish in colour, slightly curved outwards. The four anterior femora free from spines; tibiæ quadrangular, and having both of their inner edges armed with sharp spurs at short intervals, the second pair of femora having a single hind spur, about half-way down, as well as a terminal one; hind femora similarly armed with very minute barbs on their inner edges; hind tibiæ not broader behind than on the sides, with the posterior spines arranged in alternate series, sharp, slightly bent, and, proportionately to size, longer than in *Deinacrida heteracantha*. Length of the body, without appendages, 2·25in.; ovipositor, 0·75; hind femora, 1·5; hind tibiæ, 1·5; antennæ, 5.

The following account is given by Mr. Brough of the discovery:—

"Far up in the gloomy alpine woods which clothe the Karamea Saddle, and in the very heart of a red-birch forest, I came across this fine Weta for the first time. I should state, however, that I met with a still bigger one, which unfortunately I quite destroyed; and I will explain how this came about. While I was camped in the Saddle, at an elevation of 3,308ft., I noticed several holes near to the bottom of several of the old red-birch trees. The mouth of these holes seemed to me to be the entrance to a drive or home of some insect. I chopped into two or three of them with the axe, following up the tunnel, but I could not find any living insect or beetle inside. In one case I followed up the tunnel for some yards, to the

very extremity of the tunnel, which ended in a circular cavity large enough to hold a good-sized saucer; and at several places along the course of the tunnel there were enlargements or, so to speak, chambers. All the drives I examined had an upward course; I never found one commencing at the top of the tree. It was evident to me that the insect had planned its tunnel in such a way as to insure a dry house at all times. I noticed that in some places the insect had eaten its way through hard knots in the wood, nothing being allowed to interfere with the true course of the tunnel; but I looked in vain for the workman whose skill I had been admiring. I had given up the search as hopeless when one day I noticed, at a place some 600ft. below the Saddle, a very large lichen hanging over the entrance to one of these holes, which are generally a good inch in diameter. This, like all the others I had examined, was in a living tree; and, as it looked quite fresh, I determined to explore it. I first of all felled the tree with the axe, and then I followed up the tunnel for about 8ft., when I unfortunately sent the axe clean through a very large Weta—a much larger insect than the one forwarded, but of the same species. He seemed to be engaged in forming one of the chambers I have described. Not far from this place I found, on another tree, the same kind of lichen overhanging a hole, and this time I was more careful in using the axe. Here I found the insect which I send to Wellington. The altitude of this spot is something like 2,708ft. above the sea-level. Speaking generally, I should say that this species of Weta frequents dense forests, and lives by eating the heart of red-birch trees; for I observed that it always attacked growing timber. The red-birch trees are very hard, but their exterior is covered with mosses of various kinds, and the vegetation all round is very dense, much of it being composed of the forest cabbage-tree. From observing the habits of my Weta in captivity I am convinced that it is nocturnal in its habits. I had an excellent opportunity of noting his ways and doings, for I kept him in a glass pickle-jar, and he was the only camp-mate I had for some time. He seldom moved by day, unless I disturbed him; but he became quite lively by night, and at times emitted a chattering kind of sound. I had frequently heard this sound at night in the woods, but was never able to tell what produced it till I got this captive. I tried one day to measure him round the girth, but he resented this liberty, and went through some extraordinary antics, and I had to give it up. I found that he could bite fiercely, and when excited could hiss like an adder. I

may here mention that I saw a young man some time ago that had been bitten by one of the common Wetas inhabiting the lowlands. He was bitten in the wrist, and he had an awful arm; indeed, the pain nearly drove him mad. My captive Weta would eat nuts, and occasionally a little bark; but I could never induce him to eat by day. Although nocturnal in his habits, he could apparently see perfectly well in the daylight. He generally remained in a flat position, quite motionless, and looking gravely out of his glass house at the ways and doings of man."

## ART. XXXI.—*Notes on New Zealand Ornithology, with an Exhibition of Specimens.*

By Sir WALTER L. BULLER, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 21st August, 1895.*]

ON the last occasion that I had the pleasure of bringing before you a budget of ornithological notes I took the opportunity in the course of my introductory remarks to refer to the wise action of the Government in setting apart two islands—the Little Barrier at the North and Resolution Island in the South—as permanent reserves for the conservation of the indigenous fauna and flora, and I mentioned that this practical step on the part of our rulers in furtherance of natural science had been the subject of comment and praise all over the world. It will, I am sure, be as gratifying to you as it was to myself to learn that the Minister of Lands has decided on acquiring, for a similar purpose, the freehold of the Island of Kapiti, in Cook Strait. This island, containing an area of about 5,000 acres, is in every respect most suitable; so much so that, many years ago, Sir George Grey, before he purchased the Island of Kawau, made inquiries as to the possibility of acquiring Kapiti as an island sanctum for himself, where he could carry on without interruption the work of acclimatisation upon which he had set his heart. Much of the bush on the island is of exquisite beauty, and the surface is sufficiently diversified to insure the successful cultivation of all our native trees and shrubs. Three species of birds—the Wood-robin, the Korimako, and the Whitehead—which are now practically extinct on the mainland, still have their refuge on Kapiti; and Captain Ross, who has hitherto been occupying the greater portion of the open land as a sheep-run, has been

most careful to prevent dogs and cats—those great destroyers of native birds—from becoming feral on the island. It is at a convenient distance from the mainland, and seems specially designed by nature for what it will now, we may hope, soon become—the central colonial *dépôt*, so to speak, for our birds and plants. I only wish I could report that steps were being taken to give effect to Lord Onslow's original proposal, to collect rare birds in various parts of the country and turn them loose on the island preserves—such birds, for example, as Kakapo, Kiwi, Huia, and the native Crow. But that, I trust, will be the next forward step.

I regard with extreme satisfaction this gradual awakening to the fact that we have animal and vegetable forms of life indigenous to the country which ought to be protected and cherished; that we have bush scenery of matchless beauty that ought to be preserved; and that, new as our record is, we have sites of pas and other places of historic interest that ought, at any cost, to be handed down unimpaired to those who will come after us. That this growing feeling is becoming part of our national life must surely delight every true lover of New Zealand. The various Commissioners of Crown Lands all over the colony have received instructions to withhold from sale spots of exceptional beauty and all places of historic interest—such, for example, as the site of the Orakau Pa, with its tradition of "*Ake, ake, ake!*" (which, by the way, was within a few hours of being sold when the Government stepped in to save it); and the site of Rangiriri, where the Waikato tribes made their first heroic resistance before surrendering to an overwhelming force, and where so many of our own brave men lie buried. Forest reserves, like the beautiful belt of bush along the boundary of the State farm at Horowhenua, are being defined and proclaimed; and the law is being invoked for the protection, one after another, of our rarer species of birds. The only danger to be apprehended now is that by continuing the insane policy of introducing predatory animals, such as stoats, ferrets, and weasels, in the vain hope of suppressing the rabbit nuisance, the good that is being accomplished may be to a great extent counterbalanced. To my mind it is impossible to exaggerate this evil: it is so easy to introduce these bloodthirsty little animals, and so difficult to extirpate them when once fairly established and the mischief of their presence has become manifest. I have so often referred to this matter in my addresses to this society that it is not necessary for me to give reasons for the strong opinion I hold. It seems to me that we ought to benefit by the experience of other countries where these predaceous pests abound, and where large sums have been expended in the attempts to exterminate them.

No one has opposed this fatal step on the part of the New Zealand Government more strongly or consistently than Professor Newton, of Cambridge. In a letter to myself, as far back as the 23rd of July, 1876, the learned professor says,—

"In *Land and Water* for 8th July, Frank Buckland wrote that he had been applied to by Messrs. Macowie and Cuthbertson, of Invercargill, to send out weasels to New Zealand (five pairs at £5 each) to be let loose to check the superabundance of rabbits. Buckland said he could not get weasels, but proposed sending 'polecat-ferrets'—thirty or forty pairs! I at once wrote to remonstrate with him, urging him to do nothing till he had communicated with New Zealand; and this he has promised to do, but does not give up the notion. Harting, Rowley, and some one else have also protested in terms like my own, as you will see by *Land and Water* for 15th and 22nd July. I suspect Buckland will eventually drop the matter, but meanwhile it seems quite possible that some sheep-farmer or other (for with them began the complaint) may on his own responsibility act on this mischievous hint without waiting for Buckland, and then good-bye at once and for ever to your brevipennate birds, as well as to many other of your native species—which of course have no instincts whereby they may escape from such bloodthirsty enemies—to say nothing of pheasants and the like, which you have been introducing at so great a cost, and your poultry. Here, as I dare say you know, the polecat (and the ferret is only a tame polecat) is the most detested beast we have, and in consequence has nearly been extirpated. In New Zealand it will undoubtedly become master of the situation.

"So strongly do I feel on this subject that I am writing to Hector (both at Wellington and Philadelphia, to make sure of catching him) urging him to use all his influence to prevent such a disastrous importation; even, if need be, to getting an Act of your Parliament prohibiting the introduction of any predaceous animals. Should Hector not have returned, I pray you to do what seems best under the circumstances; but be sure there is no time to be lost. I am writing to Hutton to the same effect, and I trust that among you all you will be able to keep off the threatened scourge. Colonists in general have not been slow to hinder unacceptable importations from the mother-country—as witness the historic tea-chests at Boston, U.S.A., and Australian convicts. I have always understood the latter were selected for the mild nature of their crimes: but even this was not allowed. There can't be a doubt of how you should behave when you have a shipload of known marauders to be let loose on your peaceful shores, and I conceive my duty as an honorary member of

your Institute compels me to give you this timely notice. It is too annoying to think that the fate of your fauna should depend on the rash act of the greatest fool that was ever called a naturalist."

Mr. J. Brough informs me that, owing principally to the introduction of stoats, the Grey Kiwi has now entirely vanished from wooded districts near Nelson, where formerly it was so abundant that he has collected a score in a single locality.

From all parts of the country I continue to receive reports of the ravages of stoats and weasels. From Nelson Mr. R. I. Kingsley writes to me, "I hear there is a likelihood of stoats and weasels being turned out by the Government at West Wanganui. It will be a great shame if they are, as it will mean destruction to the Big Kiwi; and the rabbits at West Wanganui are only found on a small strip of sandy beach. They have been there for many years and never spread; therefore they could easily be destroyed by other means. Could you not speak a word to avert the danger?"

It seems to me that the only chance of arresting this deplorable evil is by directing public opinion against it. Unfortunately, most people are indifferent about it, and the Government yields to the clamour of a few faddists whose one idea is to exterminate the rabbits at any cost to the country. We have no guarantee, however, that these animals will suppress the rabbit nuisance, whilst we have the most positive evidence that, as in every other country they inhabit, they are themselves proving a curse in New Zealand. Mr. William Townson, of Westport, wrote me some time ago, saying, "I am told by bushmen and diggers living back in the ranges that it is becoming quite common now to see Grey Kiwis lying dead about the bush. The weasels are blamed for this, as they are now fully established on the coast as far south as Ross and Okarita. Indeed, several have been seen in this district. I fear that all the ground-game and native birds will fall victims to these little bloodsuckers. In this part of the country we have no rabbits to engage their attention."

It may be said, in reply to this, that there is no direct evidence that the dead Kiwis were the victims of these marauders; but, as a matter of fact, birds do not die about the woods of their own accord, and their partial mutilation generally tells its own tale. It is very remarkable, indeed, how seldom one finds the bodies of birds or mammals that have apparently died a natural death. In New Zealand, casting my mind back over a period of five-and-thirty years, I can count on the fingers of one hand the cases in which I have found the bodies of birds dead from natural causes. Of course, I do not refer to

the cases, of not infrequent occurrence, when the sea-beach is found strewn with the dead bodies of *Prion turtur* and other oceanic species, because it is well known that this is the result of a sudden gale towards the land, or some other wide-spread cause, the deaths in this case being violent rather than natural ones. So at the Auckland Islands, and in similar localities, the ground is sometimes found covered with hundreds of dead Penguins; but this is apparently due to some fatal epidemic, causing widespread mortality. On the mainland you may wander for months in the woods without ever seeing the body of a bird "dead from natural causes." Nowadays, unfortunately, nothing is more common than to find a Kiwi or a Woodhen lying on the bush-path torn and mutilated by stoats and weasels; but this, again, is the result of violence. I remember years ago picking up a dead Riroriro (*Gerygone flaviventris*) under a huge kauri-tree. This was after very severe weather, to which the little warbler had apparently succumbed. On another occasion, when seeking refuge from a violent storm on the Island of Motu-taiko, in the Taupo Lake, on making an exploration in the vicinity of our camp I found on a rocky ledge the perfect skeleton of a large River-shag, which had evidently died a natural death there and escaped the vigilant eyes of the ubiquitous Harrier (*Circus gouldi*). Once I found a Kaka by the roadside in a dying condition, and occasionally I have met with dead bodies of the Tui and Korimako. But the occurrence is confessedly a rare one. The same observation has been made by naturalists all over the world. That careful observer, Nordenskiold, says, "During my nine expeditions in the arctic regions, where animal life during summer is so exceedingly abundant, the case just mentioned"—that of finding a number of self-dead fish on the sea-bottom near one of the islands in the Arctic Sea—"has been one of the few in which I have found remains of recent vertebrate animals which could be proved to have died a natural death. Near hunting-grounds there are to be seen often enough the remains of reindeer, seals, foxes, or birds that have died from gunshot wounds, but no self-dead polar bear, seal, walrus, white whale, fox, goose, auk, lemming, or other vertebrate. The polar bear and the reindeer are found there in hundreds, the seal, walrus, and white whale in thousands, and birds in millions. These animals must die a 'natural' death in untold numbers. What becomes of their bodies? Of this we have for the present no idea, and yet we have here a problem of immense importance for the answering of a large number of questions concerning the formation of fossiliferous strata." Referring to this, Mr. H. H. Howarth says, "This is true not only of Siberia; it is universally true, and notably of the great pachyderms. Travellers who

have visited their ordinary haunts have remarked on the extraordinary scarcity of their bones and other remains. When old and worn out they apparently seek out the recesses of the forest and retire there to die." He quotes an interesting passage from Sir Emerson Tennent's work on Ceylon, as follows: "Frequenters of the forest with whom I have conversed, whether Europeans or Singhalese, are consistent in their assurances that they have never found the remains of an elephant which had died a natural death. . . . A European gentleman, who for thirty-six years without intermission has been living in the jungle, ascending to the summit of mountains in the prosecution of the trigonometrical survey, and penetrating valleys in tracing roads and opening means of communication—one, too, who has made the habits of the wild elephant a subject of constant observation and study—has often expressed to me his astonishment that, after seeing many thousands of living elephants in all possible situations, he had never yet found a single skeleton of a dead one, except those which had fallen by the rifle."

The following touching account is given by Thomas Edward, the Scotch naturalist, of the finding of a dead wild duck, on crossing the Clashmauch: "As I imagined she was skulking with a view to avoid observation, I touched her with my stick in order that she might rise; but she rose not. I was surprised, and, on a nearer inspection, I found that she was dead. She lay raised a little on one side, her neck stretched out, her mouth open and full of snow, her wings somewhat extended, and with one of her legs appearing a little behind her. Near to it there were two eggs. On my discovering this I lifted up the bird, and underneath her was a nest containing eleven eggs; these, with the other two, made thirteen in all: a few of them were broken. I examined the whole of them and found them, without exception, to contain young birds. This was an undoubted proof that the poor mother had sat upon them from two to three weeks. With her dead body in my hand I sat down to investigate the matter, and to ascertain, if I could, the cause of her death. I examined her minutely all over, and could find neither wound nor any mark whatever of violence. She had every appearance of having died of suffocation. Although I had only circumstantial evidence, I had no hesitation in arriving at the conclusion that she had come by her death in a desperate but faithful struggle to protect her eggs from the fatal effects of the recent snow-storm. I could not help thinking, as I looked at her, how deep and striking an example she afforded of maternal affection. The ruthless blast had swept, with all its fury, along the lonesome and unsheltered hill. The snow had risen higher, and the smothering drift came fiercer as the night drew on; yet still

that poor bird, in defiance of the warring elements, continued to protect her home and the treasure which it contained, until she could do so no longer, and yielded up her life. That life she could easily have saved had she been willing to abandon the offspring which Nature had taught her so fervently to cherish, and in endeavouring to preserve which she voluntarily remained and died. Occupied with such feelings and reflections as these, I know not how long I might have sat had I not been roused from my reverie by the barking of a shepherd's dog. The sun had already set, the grey twilight had begun to hide the distant mountains from my sight, and, not caring to be benighted on such a spot, I wrapped a piece of paper, as a winding-sheet, round the faithful and devoted bird, and, forming a hole sufficiently large for the purpose, I laid into it the mother and the eggs. I covered them with earth and moss, and over all placed a solid piece of turf; and, having done so, and being more affected than I should perhaps be willing to acknowledge, I left them to moulder into their original dust, and went on my way."

But to resume my subject: The effect of these foreign introductions is to accelerate the threatened wiping-out of an avifauna admitted to be one of the most interesting in the world. Many of the species have already disappeared: a still larger number are, so to speak, on the border-land and will ere long be extinct, whilst even the commonest species exhibit year by year a steady diminution in numbers. What the result will be in, say, twenty years from the present time it is not difficult to predict. And the consideration of these facts brings me at once to the urgent necessity that exists for completing our collections of these forms before it is too late. Foreign museums are being enriched whilst our local museums are practically at a standstill. By last mail I received a letter from Canon Tristram, of Durham, informing me that at a recent meeting of the Zoological Society, in London, the Hon. Walter Rothschild had exhibited a series of no less than forty skins of our hitherto-rare *Apteryx haasti*, of which, so far as I am aware, only eight specimens exist in all our New Zealand museums. He adds that Mr. Rothschild has obtained "enormous series" of other New Zealand birds. For example, there are fifty-four specimens of the Chatham Island Snipe, of which our local museums contain very few examples; and very large series of the beautiful Chatham Island Shag (*Phalacrocorax featherstoni*), of which, so far as I know, the Colonial Museum possesses the only example in the colony; and the still more striking *P. onslowi*, of which there is no representative in any of our museums. Dr. Hartert, the excellent curator of Mr. Rothschild's museum, in a letter to myself states that the collection contains eighty specimens of

the Flightless Duck of the Auckland Islands (*Nesonetta auck-landica*); and this bird is now so rare that, on the last visit of the "Hinemoa" to those islands with His Excellency the Governor, Sir James Hector, who accompanied the expedition and was most anxious to procure some for the Cambridge University Museum, found the utmost difficulty in collecting three specimens, although the whole ship's crew were on the look-out for them; and so with several other comparatively rare species. Of course, it is a good thing that these extensive collections have found their way into Mr. Rothschild's possession, because he makes excellent use of them, being himself one of the most active of our working ornithologists; besides which he is a liberal donor to other public museums. His own zoological museum at Tring Park is one of the most perfect of its kind in the world. It contains priceless treasures, and its great merit in the eyes of a practical ornithologist is that it possesses huge series of specimens, whenever that is possible, thus minimising the ever-present danger of generalising on insufficient data. But, whilst fully recognising all this, one cannot but acknowledge and deplore the fact that in our own museums nearly all the native species are imperfectly, or, at any rate, insufficiently, represented.

Canon Tristram himself has a beautiful collection of New Zealand birds, comprising all the rarer forms, but he is content with a small series of each species, such as male, female, young, and seasonal states. It is to be hoped that his splendid collection of birds from all parts of the world—the accumulation of a lifetime—may ere long find a resting-place in one of the provincial museums, instead of being dispersed, as too often happens, at the owner's death. That was the fate of the celebrated Jardine collection, when some very choice and rare New Zealand specimens found their way into other hands. This collection contained many skins procured in New Zealand by Mr. Percy Earl, and purchased by Sir William Jardine as far back as 1842 — such forms, for example, as *Coturnix novæ-zealandiæ* and *Pogonornis cincta*.

Whilst the Rothschild Museum boasts the possession of seventy or more Stitch-birds (*Pogonornis cincta*) of both sexes, the Colonial Museum and the Auckland Museum are the only ones that can exhibit sexual pairs of this species, which now exists on the Little Barrier Island and nowhere else. To say nothing of so rare a form as *Notornis mantelli*—of which there are only three known specimens, two in the British Museum and one at Dresden—there are many of our indigenous birds wholly absent from our local museums, whilst others have only a single representative. For example, the Colonial Museum possesses one Auckland Island Merganser and one

North Island Thrush, and the other museums in the colony are entirely without them. This being so, it is surely high time that an effort was made to collect for each of our museums, before it is too late, a complete series of our existing native birds—at any rate, for the Colonial Museum, which is maintained by the Government and is supposed to take the lead. This might be easily accomplished now, but ere long it will be impossible. It is to such a museum as this that the student of the future will naturally look for his working material when the forms of which I have been speaking have passed away for ever from the sphere of living things. It will be a sad reproach to us, living as we do in this boasted nineteenth century, if in this respect we fail in our manifest duty. An excellent collection of the interesting insular forms could be made by sending such a taxidermist as Mr. Yuill (of whose neat work there are some illustrations now on the table) on two or three round cruises of the "Hinemoa." An enthusiast such as he is, with the necessary facilities at his command, would soon accumulate a collection for the colony of very great value.

And this brings me to the question of the proper display of such collections in our museums, so as to make them subservient to the requirements of modern science.

At the present time we have in the Colonial Museum upwards of three hundred mounted specimens of indigenous birds, a large proportion of them being highly creditable exhibits of the taxidermists' skill; but how are they arranged? Not systematically, according to their natural affinities, because of the want of the necessary room for their proper classification and display. The only grouping that is natural is such as is now to be seen in the admirably-arranged galleries of the Natural History Museum at South Kensington, where, in separate plate-glass show-cases, birds of one species, representing the sexes, the adult, young, and adolescent states, and the various phases of seasonal plumage, are exhibited, together with the natural accessories of wood and rock and vegetation, to illustrate the life-history of the bird. Such a mode of exhibition is not only attractive in the highest degree, but most instructive. Of course, we cannot attempt anything so ambitious here, on account of the great expense; but there is no reason why the birds should not be arranged systematically for the benefit of the natural-history student. This has been done in the Canterbury and Otago Museums, and I think also in Auckland. It seems little short of a scandal that, owing to the lack of proper departmental aid, scientific classification should be neglected in the leading museum of the colony, which is admittedly under the control of a director of exceptional ability and culture. Then, again,

if I may be allowed to speak plainly, the nomenclature adopted is not up to date, some of the names attached to specimens having been obsolete these twenty years, whilst fully half of those exhibited are not named at all. If the Museum is to be regarded as an educational institution, as it clearly should be, an antiquated nomenclature is not only confusing but misleading.

And here I may say, parenthetically, that there is one innovation in the matter of scientific nomenclature, now becoming very popular, which will, I hope, be resisted in this country, and that is the use of trinomials. In Ridgway's "List of North American Birds" trinomial designations are adopted in no less than 160 cases. The author candidly acknowledges that the use of them has caused perhaps the greatest difficulty encountered in the compilation of the catalogue, "it being in many cases very difficult to decide whether a given form should be treated as having passed the varietal stage and therefore to be designated by a binomial, or whether it is as yet incompletely differentiated and to be subordinated in rank by a trinomial appellation." His contention, however, is that every form whose characteristics bear unmistakably the impress of climatic or local influences, generally less marked towards the habitat of another form with which it thus intergrades, and all forms which certainly intergrade, no matter how widely distinct the opposite forms may appear, together with intergrading forms whose peculiarities are not explained by any known law of variation, should be reduced to subspecific rank. Commenting on this, the editor of the *Ibis* writes, "We cannot deny the advantages of the use of trinomials when strictly limited to such cases as these, and have little doubt that they will ultimately come into general use. But they can only be advantageously employed in countries such as North America and Europe, where large series can be obtained from different localities. In other parts of the world their use would at present be attended by much inconvenience, it being impossible to ascertain in very many cases, from lack of specimens, whether these intergradations exist or not. We may also remark that other authors use trinomials on quite different principles—*e.g.*, Dr. Sharpe, who in his Catalogue of Birds (British Museum) has applied them in some instances even to insular forms (which certainly cannot intergrade) where the slight differences are, in his opinion, not strictly sufficient for specific distinction."

I submit that what I have now called attention to as defects in the Colonial Museum might be easily remedied; and that the value of the Museum as an instrument of public instruction would be vastly increased if the Director could

get authority to prepare a descriptive catalogue for the use of visitors and students. This would involve a little expense, but it must be borne in mind that the Museum, as a whole, contains collections of considerable value, and that in the absence of a catalogue the general public has no conception of what the colony possesses in this respect. I do not know what the estimated value is in money, but I should say certainly not less than £30,000; and all this accumulated through the exertions of Sir James Hector, who had nothing but the small miscellaneous collection of the New Zealand Society to start with. The truth is that the Colonial Museum is not large enough for the exhibition of the treasures it contains. When it was built, some thirty years ago, the various collections were in their infancy, and very few additions have since been made to the building. Now that an effort is being made to recover, for educational purposes, the beautiful site on which the Central Criminal Gaol stands, it might be well to consider whether the site of the present Museum should not be sold at a good price, and the proceeds applied to the erection of a really suitable building on a portion of the fourteen acres comprised in this Mount Cook reserve.

Before passing on to my notes on the species selected for particular mention this evening, I should like to say that the Legislature is to be congratulated on having by special enactment extended a very necessary protection to our splendid Wood-pigeon, by making the whole of the year 1896 a close season. It is to be hoped that the Government will not make too free a use of its discretion under the Act as to relaxing the restriction in native districts. I may mention, too, that Sir James Hector has performed an important service to science by obtaining legal protection for that unique representative of an ancient fauna, the Tuatara Lizard. To take or kill one of these animals is now punishable with a heavy fine. This course was rendered necessary by the wholesale way in which Tuataras were being collected for trade with Europe and America. This may seem a digression from the subject-matter of my paper; but the Tuatara is the foster-brother, so to speak, of several species of Petrel, inhabiting the same burrows and breeding in adjoining chambers; and, although it belongs to a lower order in the animal kingdom, it is known to possess the most bird-like skeleton of all existing reptiles.

These introductory remarks will prepare you for the ever-recurrent record of increasing rarity of many of the species treated of in the following notes. Their ultimate extinction within measurable time is a matter of certainty, except in so far as a remnant may be preserved through the protective action of the Government to which I have referred.

**Creadion cinereus**, Buller. (Jack-bird.)

In forwarding the specimen now exhibited my correspondent writes, "During the whole four months I was camped in the woods on the Karamea Saddle I only heard one Saddleback. I managed to secure it, and may remark that it is the largest-boned bird of the kind I ever shot. The colours are plain, but the bird is in perfect plumage. I cannot say whether it is a male or female, for before I had time to make a dissection, after skinning it, the Woodhens ran away with the carcase."

**Miro ochrotarsus**, Forster, Desr. Anim., p. 82 (1844).

After a careful investigation of the subject and a comparison of a large number of specimens, I have come to the conclusion that there are in reality three forms of Wood-robin in New Zealand, all of course descendants from a common stock, but now sufficiently differentiated to bear distinctive specific names. The North Island bird was the first to be recorded. This is *Miro australis*, formerly the commonest species in our woods, and now almost if not entirely extinct on the mainland, but to be met with on the Little Barrier Island at the north, on the Island of Kapiti in Cook Strait, and probably on other outlying islands near our coasts. The two other forms belong to the South Island, and have hitherto been confounded under the general name of *Miro albifrons*.

Mr. G. R. Gray, in the "Voyage of the 'Erebus' and 'Terror'" (part "Birds"), thus describes *Miro albifrons*: "Upper surface and forepart of neck sooty-black; under surface pale-rufescent; front with a small spot of white. Length 7in." This is the *Turdus albifrons* of Gmelin's Syst. Nat., p. 822.

Now, that description exactly fits the two examples (male and female) from Pelorus Sound which I have the pleasure of exhibiting this evening. But Mr. Gray's description does not accord with the coloured figure which he gives of the bird. Referring to this figure, in my account of the species ("Birds of New Zealand," p. 36) I said, "The figure of this species in the 'Voyage of the "Erebus" and "Terror"' is incorrect, on account of the exaggerated extent of white on the underparts; but the attitude is a very characteristic one." It seems pretty clear, therefore, that the description and the figure represent different birds.

After diagnosing *Miro albifrons*, as quoted above, Mr. Gray says, "The original of this description is contained among the drawings of Forster, and it is very like *Petroica longipes*, Garn. (= *Miro australis*). The figure of Forster differs, however, from the bird referred to by the white extending from the forepart of the breast to the base of the tail, leaving the throat of the same colour as the back. I have subjoined a

figure, for the purpose of making known the original drawing from which Latham took his description, that it may assist in elucidating the species should it hereafter be discovered."

Now as to the other form, of which I exhibit this evening six specimens, obtained in the high wooded country known as the Karamea Saddle. This bird can be distinguished at a glance from *Miro australis*, and Gray's figure suits it fairly well. It is appreciably larger than the last-named species, and, instead of having the abdomen white as in that bird, or the under-parts rufescent as in *Miro albifrons*, it has almost the entire under-surface of a pale lemon-yellow. The frontal spot, too, instead of being very small, as described by Mr. Gray, is even more conspicuous than in the North Island bird.

Writing of *Miro albifrons* Mr. Gray says, "It may eventually prove to be the same species as *M. longipes* (=*M. australis*); and in my own account of this form (*op. cit.*, p. 36) I remarked, "My collection contains a specimen from Christchurch in which the whole plumage is suffused with brown, and the under-parts are smoky-grey instead of being white." I have since received an example from Otago which is scarcely distinguishable from ordinary specimens of *Miro australis*.

On a review of all the facts I am disposed to define the group thus:—

*Miro australis*, Sparrm. North Island form; with under-parts, within very narrow abdominal limits, pure white.

*Miro albifrons*, Gmelin. South Island form; with under-parts rufescent, and over a wider surface.

*Miro ochrotarsus*, Forster. Another South Island form; with almost the entire under-surface pale lemon-yellow. Conspicuous spot of white on forehead.

*Female.*—Similar to the male, but a trifle smaller, and paler in plumage.

Whilst thus recognising a third form I have no wish to invent a new name. As there is some doubt as to which bird was intended to be distinguished as *Miro albifrons*, and as that name is retained for the other South Island form, I think we cannot do better than fall back upon Forster's proposed name, *Turdus ochrotarsus*, simply shifting the species into the genus to which it now belongs.

Forster's original account is as follows: "Habitat in australi insula Novæ Zeelandiæ, victitat insectis et minutis cancellis ad littora maris, suaviter cantillat; homines non formidat, sed ubique ob insecta in ambulando inter fructices excussa et circumvolitantia sequitur, sæpius manu captus vel pileo."

**Miro albifrons,** Gmelin. (South Island Robin.)

A correspondent, writing over the initials "S.D.B.," sends the following to the *Lyttelton Times* of the 24th of April: "A very interesting case, showing the usefulness of a purely insectivorous bird, came under my notice the other day, and is, I think, worthy of record. A friend was showing me his vinery, and I was astonished to see in it a tame Robin (*Petroica albifrons*) following him about in its characteristic fearless manner. The bird was in as perfect plumage as if in its native bush, although now quite domiciled in the greenhouse, which it keeps free from insect-life without injuring the vines or grapes. I was informed that the Robin occasionally gets out into the garden, but is then easily induced to return to the vinery, which is, of course, kept locked when the owner is away. I asked if it did not want a mate, but was told that these birds are very pugnacious, and would fight like gamecocks if shut up together. Certainly this fellow seemed quite happy by himself."

**Myiomoira toitoi,** Garnot. (North Island Tomtit.)

It seems probable that the male of this species aids in the task of incubation, for an adult bird of this sex, shot in November, had the under-parts much denuded of feathers.

**Sphenœacus rufescens,** Buller. (Chatham Island Fern-bird.)

Mr. W. Hawkins, the well-known Chatham Island collector, writes to me, "The Fern-bird is extinct. I spent a fortnight on the island where they used to be, but never saw any sign whatever of them."

**Anthus novæ-zealandiæ,** Gray. (New Zealand Pipit.)

It is very clear that these birds congregate in autumn. During a ride to and from Owhaoko (22nd to 29th April) I met with numerous flocks, numbering from twenty to fifty at a time. I hardly saw a single bird detached from the flocks. I have already noticed the inquisitive disposition of this Pipit, and mentioned the circumstance of a flock keeping pace with a train for some miles. There is another evidence of it: as you ride along the road they keep before you, almost allowing your horse to tread on them, then rising with a shrill "cheep," flying a few yards further, and so on again till their curiosity is satisfied, when they wheel upwards and fall to the rear.

**Anthornis melanocephala,** Gray. (Chatham Island Bellbird.)

Of this species Mr. Hawkins writes, "This bird, too, is very nearly extinct. I have no difficulty in selling the skins

for £1 apiece; so I have sought diligently for them, but it is very difficult to get any of them now."

**Xenicus insularis,** Buller. (Island Wren.)

There is probably nothing so refreshing to the soul of a naturalist as the discovery of a new species. Quite apart from the satisfaction of being able to impose a specific name which, according to the accepted rules of zoological nomenclature, must be respected for all time, there is an indescribable charm in the mere fact of discovery. It is common to all naturalists in every branch of research, and operates as a spur to the most tedious and difficult investigations. With some specialists the ruling passion is to append the coveted *mihi* to the new species; but in the case of most naturalists this consideration is, I really think, subservient to a loftier feeling—that love of discovery which is so characteristic of the true man of science. In a country where the fauna and flora have been pretty thoroughly worked, such as New Zealand, the delight experienced at finding an undoubted new species is, of course, proportioned to the rarity of such occurrences. You will readily understand, therefore, how pleased I was at receiving, through the kind offices of Mr. Bethune, the skin of a bird from Stephen Island which was entirely distinct from anything hitherto known. I saw at a glance that it belonged to the small group of New Zealand birds which I have placed in a family by themselves under the name of *Xenicidæ*. Possessing characters in common with *Xenicus longipes* and *X. gilviventris*, which inhabit the mainland, it is a very distinct species, apparently restricted in its habitat to Stephen Island, where several specimens have been procured. Being anxious that a coloured figure of so rare and interesting a form should be published in the *Ibis*, I lost no time in forwarding the specimen to the editor of that magazine, together with the following description and diagnosis of the species:—

"*On a New Species of* Xenicus *from a Small Wooded Island off the New Zealand Coast.*

"Projecting into Cook Strait as a bold and salient point from the eastern shore of Blind Bay, and rising to a height of 2,180ft., is D'Urville Island, presenting a broken and partially-wooded surface. With a width of from five to six miles, it stretches away seventeen miles to the northward, whilst to the south it is separated from the mainland by a very narrow channel known as the French Pass. Lying two miles to the north-eastward of the northern extremity of D'Urville Island, and rising abruptly from the sea to the height of a thousand feet, is Stephen Island, only about a square mile

in extent, and more or less wooded on its sides. From this island I have lately received a single specimen of a species of *Xenicus* entirely distinct from the two forms (*X. longipes* and *X. gilviventris*) inhabiting the mainland.

"I have described and named this new bird, which may fittingly be called the Island-wren, as distinguished from our Bush-wren and Rock-wren; and as these island-forms present features of special interest to the student of geographic zoology, I am forwarding the specimen in the hope that it may be figured.

"My correspondent on the island informs me that the bird is semi-nocturnal in its habits, and that he has seen three examples, all of which were brought in at different times by the cat.

"I hope shortly to receive further specimens of this interesting form. In the meantime I regret that I am unable to give the sex of the bird here described. In plumage it differs conspicuously from the other two species, and it has a decidedly more robust bill, whilst the claw on the hind-toe is not larger than in *Xenicus longipes*.

"*Xenicus insularis*, sp. nov.

"Upper surface generally dark-olive with brown margins to the feathers, presenting an obscurely-spotted or mottled appearance; a minute whitish spot in front of and another underneath the eye; a narrow superciliary streak, and the whole of the throat, fore-neck, and breast, as well as the wings at their flexure, olivaceous-yellow with darker margins; wings and tail, sides of the body, abdomen, croup, and under tail-coverts olivaceous-brown. Plumage underneath plumbeous. Upper mandible dark-brown with horn-coloured tip; under mandible, legs and feet, pale-brown. Length, 4in.; wing from flexure, 2in.; tail, 0·75in.; bill, along the ridge 0·75in., along the edge of lower mandible 0·75in.; tarsus, 0·75in.; middle toe and claw 1in., hind toe and claw 0·7in.

"*Hab.* Stephen Island, Cook Strait, N.Z."*

I have since had an opportunity of examining a female specimen. It is somewhat smaller than the male, and has duller plumage, the mottled appearance on the upper surface being less conspicuous, and there being more vinous-brown on the sides and abdomen.

Referring to this interesting discovery, an article, presum-

* Some weeks after my specimen had reached the editor of the *Ibis*, and whilst Mr. Keulemans was preparing a drawing of it, Mr. Henry Travers sent specimens from the same locality to the Hon. Walter Rothschild, who, without knowing what I had done, characterised the species in the "Bulletin" of the British Ornithologists' Union under the name of *Traversia lyalli*.

ably from the pen of a well-known New Zealand scientist, appeared lately in the Canterbury *Press*, under the head of "Found and Exterminated," from which I take the following extract: "At a recent meeting of the Ornithologists' Club in London, the Hon. W. Rothschild, the well-known collector, described this veritable *rara avis*, specimens of which he had obtained from Mr. Henry Travers, of Wellington, who, we understand, got them from the lighthouse-keeper at Stephen Island, who in his turn is reported to have been indebted to his cat for this remarkable ornithological 'find.' As to how many specimens Mr. Travers, the lighthouse-keeper, and the cat managed to secure between them we have no information, but there is very good reason to believe that the bird is no longer to be found on the island, and, as it is not known to exist anywhere else, it has apparently become quite extinct. This is probably a record performance in the way of extermination. The English scientific world will hear almost simultaneously of the bird's discovery and of its disappearance before anything is known of its life-history or its habits. It was only a little creature, about four inches in length, allied to the little Rock-wren, which lives in the mountains, and is occasionally found dead on our glaciers. It was not a flightless bird, but from its structure was evidently very weak-winged, and thus fell an easy prey to the lighthouse-keeper's cat. . . . Not only scientists, but all New-Zealanders who take an interest in the preservation of whatever is specially characteristic of the colony, will deplore the extermination of such an interesting creature. It is, indeed, saddening to reflect how, one by one, the rare and wonderful birds which have made New Zealand an object of supreme interest among scientists all over the world are gradually becoming extinct. . . . And we certainly think it would be as well if the Marine Department, in sending lighthouse-keepers to isolated islands where interesting specimens of native fauna are known or believed to exist, were to see that they are not allowed to take any cats with them, even if mouse-traps have to be furnished at the cost of the State."

Mr. W. W. Smith, of Ashburton, in a letter to the same journal, writes, "The setting-apart of the Little Barrier and Resolution Islands as sanctuaries for vanishing native birds is a lasting honour to the originator of the scheme—the Earl of Onslow—and the present Government who adopted and put it in force. But, as Mr. Purnell observes, 'It is one thing to maintain preserves of native birds in two secluded spots, inaccessible to the vast majority of the inhabitants of New Zealand, and quite another to have those birds fluttering daily about us.' It is for the rare species still lingering in the forests and other favoured spots on the mainland we appeal;

and if the Government would act as promptly in stopping marauders, commonly called natural-history collectors, from visiting the outlying islands of New Zealand and carrying off the Tuataras and rarer birds by hundreds as it did the seal-poachers in the southern islands last year, it would gain the gratitude of science and coming generations."

With the views thus forcibly expressed it is impossible not to agree; and I believe measures for the better conservation of these island faunas are now under the consideration of the Government. But the collection of skins for trade purposes is, of course, a very different thing to the formation of a complete type-collection for the Colonial Museum, as advocated in the introduction to this paper.

**Xenicus longipes**, Gmelin. (Bush-wren.)

A correspondent has sent me for examination some beautiful specimens of the Bush-wren, accompanied by the following notes:—

"Far up in a gloomy, wet mountain gully, nearly 4,000ft. above the level of the sea, I came across a few families of this little silent bird. In the gully which they were inhabiting grew a dense mass of a flax-like plant—a species of *Astelia*. These birds seem to display more of the golden colour at the bend of the wing than any I have seen before, and they do not appear to be so large as those I sent you from the Big Bush some years ago. All my specimens of this bird were obtained by using a small net.

"I have not met with any Rock-wrens up in this district. From where I was camped, half an hour's climb took me into the open country—a bare mountain-side, in fact. I had a long ramble over the rugged ridges and across the mountain-slopes, or 'mountain meadows' as they are called. I went to the summit of Mount Nugget, 4,995ft., and then I went in another direction to the summit of Mount Luna, 5,261ft., but I never saw or heard a Rock-wren. It is clear that the species does not exist in this part of the country.

"I have been much impressed by the stillness and the almost entire absence of animal life in these red-birch forests, so entirely different from my experience in the Pelorus woods. There, as I lay in my tent at sunrise, the woods fairly rang with the chorus of songsters, the introduced Finches, Thrushes, and Starlings joining in with the native birds. They seem to me to be sun-worshippers. I have timed them with my watch, and find that the concert lasts just an hour. Here, on the contrary, there is no sun-worship. I have often listened in my tent at break of day, waiting for the song to commence, but there has been nothing but a chirp or two, or the note of a Kaka passing overhead. And here I may remark

that the note of the Kaka in these woods is very different to anything I have heard elsewhere—a fact also noticed by Mr. Saxon, the surveyor. It is something like this: 'Motuaka—hurry up,' followed by a shrill whistle—like a shepherd calling his dog. I shot one or two. but I could observe nothing different from other Kakas; only at this season (April) they were nothing but bones and feathers."

**Eurystomus pacificus**, Latham. (Australian Roller.)

Stray examples of this well-known Australian species still continue to be heard of in New Zealand. Mr. Walling Handley, writing to me from Blenheim on the 22nd December, says, "During the month of November a specimen of the Australian Roller, in perfect plumage, was shot at the Weld's Hill Station, Awatere, by a station-hand. The bird was first noticed flying with a peculiar uncertain flapping flight over the tussock grasses in quest of moths in one of the paddocks adjacent to the station. Its handsome appearance, as seen by the waning light of eventide, and the striking contrast it presented to the sombre brown of the surrounding vegetation, excited attention, and this led to its pursuit and capture. The plumage, &c., corresponds in every particular with the technical description of the species as given in your 'Manual of New Zealand Birds.'"

**Halcyon vagans**, Lesson. (Kingfisher.)

The following paragraph appeared in the *Rangitikei Advocate*: "A Paraekaretu farmer, who had unaccountably lost several hives of bees, at length discovered that the losses were due to a Kingfisher, which, on being killed, was found to have its crop full of bees."

**Platycercus novæ-zealandiæ**, Sparrm. (Red-fronted Parrakeet.)

Mr. Alexander MacDonald, of the Awahuri, mentioned to me a curious incident which had come under his own observation. His young people had obtained a nest of young Parrakeets, and succeeded in rearing them. When adult, two of the birds mated and became quite inseparable, always occupying the same perch, and cuddling up to each other in the most affectionate manner. One day the male bird made his escape from the cage, and in being recaptured had his tail pulled out. Thus dismantled, the fugitive went back to his cage in a very sorry plight. The female bird immediately discarded her disfigured mate, rejected all his advances, and before long paired with one of the other birds, whose caudal appendage was the very pink of perfection. But the curious part of the story has yet to come. In course of time the divorced lover

had renewed his tail, and then the inconstant lady forsook her second mate and restored to favour her "first love" in all the glory of his long, new tail. Not a bad proof, I think, that even birds are not insensible to the charms of personal appearance. It may be added that the last-deserted mate forthwith moped, refused to eat food, and died of a broken heart.

It would appear that this species breeds twice in the year. A young bushman at Hawera found, in the month of May, a nest containing eight young ones, which he took and sold for 10s. each, the village settlers being very partial to these docile and imitative pets.

I have examined a caged Parrakeet brought by Mr. Ernest Bell from Curtis Island, situated a few miles from Sunday Island, in the Kermadec Group, where also this Parrakeet was abundant till the introduction of the domestic cat, which soon killed them off. I can detect no difference from the New Zealand bird. It is of decidedly small size (probably a female), and there is a blue tinge on the tail-feathers; but I take these to be merely individual peculiarities. Macaulay Island, where a distinct species closely allied to *P. novæ-zealandiæ* is said to exist, lies about a degree distant from Sunday Island.

**Platycercus erythrotis,** Wagl. (Island Parrakeet.)

This species has a peculiar cry—a short, shrill note—which further distinguishes it from *Platycercus novæ-zealandiæ.*

A caged bird, from Antipodes Island, having died in my possession, I am enabled to furnish measurements from a specimen in the flesh: Extreme length, 17in.; extent of wings, 12in.; wing from flexure, 5·75in.; tail, 6in.; bill, along the ridge 0·90in., along the edge of lower mandible 0·50in.; tarsus, 0·90in.; longer fore-toe and claw, 1·25in.; longer hind-toe and claw, 1·20in.

**Nestor meridionalis,** Gmelin. (Kaka.)

As I have fully explained in the "Birds of New Zealand," there are many well-defined varieties of this characteristic species. I have enumerated and described (at pages 151–157) no less than twelve of such varieties. One of these is the large Kaka of the South Island (*Nestor montanus*, Haast). The late Sir Julius von Haast, in sending me specimens, wrote, "Even judging from its habits alone, it is quite distinct from the common Kaka. It is never found in the *Fagus* forest, whilst the other species never goes above it into the subalpine vegetation." And Sir James Hector, writing to me of the same bird, said, "I never met with it in the forests of the lowlands. It is more active in its habits and more hawk-

like in its flight than the common *Nestor*. It often sweeps suddenly to the ground; and its cry differs from that of the common Kaka in being more shrill and wild." Reviewing these opinions, I said (*op. cit.*, p. 153), "No doubt some naturalists will be disposed to regard this larger race as a distinct bird, and for a considerable time my own inclinations were in that direction; but, looking to the extreme tendency to variation in this species, and to the difficulty of drawing a clear line between the larger and smaller races in consequence of the occasional intermediate or connecting forms, I feel that I am taking a safe course, concurrently with Dr. Finsch, in refusing, for the present at least, to separate these birds." That is how the matter rests now; but I am always open to conviction, and would welcome any further information on the subject. I have already a piece of evidence which, so far as it goes, seems rather to strengthen the view of the species being distinct. It is this: The nestling of the North Island Kaka as described by myself (*op. cit.*, p. 151) is "covered with soft white down, thinly distributed, and very short on the under-parts; abdomen entirely bare; bill whitish-grey, the upper mandible armed near the tip with a white horny point; cere pale-yellow; legs dull-cinereous." A nestling brought from the West Coast Sounds, and submitted to me as a skin, was covered all over with short slaty-grey down; bill greyish-horn colour; feet brown. These nestlings, therefore, were very different, and they belonged to the two varieties.

Professor Newton writes,* "Considering the abundance of Parrots, both as species and individuals, and their wide extent over the globe, it is surprising how little is known of their habits in a wild state. Even the species with which Englishmen and their descendants have been more in contact than any other has an almost unwritten history compared with that of many other birds; and, seeing how many are oppressed by and yielding to man's occupation of their ancient haunts, the extirpation of some is certain, and will probably be accomplished before several interesting and some disputed points in their economy have been decided. The experience of small islands only foreshadows what will happen in tracts of greater extent, though there more time is required to produce the same result; but, the result being inevitable, those who are favourably placed for observations should neglect no opportunities of making them ere it be too late." And, referring to our bird, he says, "The position of the genus *Nestor* in the order *Psittaci* must be regarded as uncertain. Garrod removed it altogether from the neighbourhood of the Lories, to which, indeed, the structure of its tongue, as pre-

* 'Dictionary of Birds," p. 691.

viously shown by him, indicates only a superficial resemblance. Like so many other New Zealand forms, *Nestor* seems to be isolated, and may fairly be deemed to represent a separate family—*Nestoridæ*—a view adopted by Count T. Salvadori (Cat. B., Brit. Mus., xx., Introd., p. viii.), and fully justified by a cursory examination of its osteology, though this has hitherto been only imperfectly described and figured."

It will be remembered that at a former meeting I exhibited a specimen of the Yellow-belted Kaka named by Mr. Gould *Nestor esslingii*, in honour of the Prince D'Essling. I have now to exhibit another example of this peculiarly-coloured form, from the same locality. Seeing that no less than five have been obtained at different times, it may seem unreasonable not to accord the bird full recognition as a distinct species. But the tendency to albinism in some of the claws in the beautiful specimen now exhibited makes me still suspicious, and, for the present at any rate, it will, I think, be safer to rank it as a well-marked variety. I may mention, however, that in this bird the bill seems finer than in ordinary examples of *Nestor meridionalis*, coming nearer in this respect, as well as in the yellow colour of the under-mandible, to the very distinct *Nestor notabilis*.

**Stringops habroptilus,** Gray. (Ground-parrot.)

Major Mair informs me that the Kakapo, according to the Maoris, is still to be found in the Upper Wanganui. Formerly it was very abundant there, as also in the Kaimanawa Ranges, in the direction of Taupo. Major Mair adds, "The natives caught the Kakapo by the aid of trained dogs. The birds, when going out to feed, always placed one on sentry. The object with the kakapo-hunter was to bag this one first, then the whole family would be secured; but if the sentinel gave the alarm the others all slipped over the side of the ridge. The dogs used to wear a rattle, called by the Whanganui *tatara*, and by the Ngatimaniapoto *rore*. The purpose of this rattle was that the masters of the dogs should know where they were."

**Carpophaga novæ-zealandiæ,** Gmelin. (Wood-pigeon.)

To the many instances of albinism reported from time to time I have now to add two more. One of these is a pure albino, from the Wanganui district. The entire plumage in this bird is pure white, with just the faintest tinge of buff on the shoulders and upper wing-coverts. The other specimen is from Collingwood, and being only partially an albino presents a very peculiar appearance. The entire plumage is pure white with the following exceptions: From the lower mandible, on each side, a broad patch of purplish-black, with metallic re-

flections, passes under the eye, spreads over the ear-coverts, and extends downwards almost to the shoulder. On the inner flexure of each wing there is a patch of coppery-brown; some of the wing-coverts are brownish-grey, and the secondaries are almost wholly of that colour, the innermost ones more or less washed with coppery-brown. One of the tail-feathers is of the normal colour, freckled towards the base with white, as are several of the upper tail-coverts; bill, eyelids, and feet bright arterial red.

**Carpophaga chathamiensis**, Rothschild. (Chatham Island Wood-pigeon.)

Mr. Hawkins writes, "The Pigeon on the Chatham Islands is nearly extinct. I have been out every day for two weeks and only got four, and one of those was spoilt in the shooting."

**Larus dominicanus**, Licht. (Black-backed Gull.)

As a contribution to the history of this well-known species, the following note, furnished by Mr. Drew quite recently to the *Wanganui Chronicle*, is worth preserving: "It is not at all uncommon to see both kinds of our Seagulls as pets on lawns and gardens, but I think it very uncommon to find them nesting and producing eggs in captivity. This singularly rare ornithological occurrence has come under my notice lately. Mrs. Martin, of Wilson Street, has one of these pets; it is the large Black-backed Gull (*Larus dominicanus*), or the *Karoro* of the Maoris. The bird is quite tame—comes when called, &c. —but during the whole nineteen years of its captivity has never started egg-laying; in fact, was always thought to be a male bird. But this year, to the surprise of her mistress, she has constructed a nicely-built nest, and in it has laid three beautiful spotted eggs. 'Maori'—for so she is called—is fruitlessly sitting on her unfertile eggs—or, I should say, on two of her own and one hen's egg, for the third egg has been taken from her and is now in the Museum. I wonder if she has noticed the difference!"

**Sterna vittata**, Gm. (S. Nat., i., p. 609.)

Mr. Bethune, of the "Hinemoa," has shown me a skin of the Tern obtained by him at the Bounty Islands, for which Mr. Henry Travers had proposed the name of *Sterna bethunei*. It is a lovely bird, presenting a general resemblance to *Sterna antarctica*, but with a snow-white tail, and legs of arterial red. But the bird is not new, having been first described and named as far back as 1788 (*op. cit.*). Mr. Bethune states that it occurs at the Snares and on Campbell Island as well as on the Bounties. There were four specimens of this bird in

the collection made by the "Challenger" Expedition, from Betsy Cove and Christmas Harbour, in Kerguelen Island.

Another species of Tern obtained by Mr. Bethune at the Auckland Islands may, however, prove to be new. It is similar in plumage to *Sterna frontalis*, but is appreciably larger, with a longer and more robust bill. Like the last-named species it is gregarious, hunting in flocks, whereas *Sterna vittata* flies in pairs. The specimen shown to me gave the following measurements:—*

Extreme length, 17·75in.; extent of wings, 28·5in.; wing from flexure, 11in.; tail, 7in.; bill, along the ridge 2in., along the edge of lower mandible 2·5in.; tarsus, 1in.; middle toe and claw, 1·25in. If new, it may be thus diagnosed:—

*Ad. ptil. æstiv.* similis *S. frontali* sed paullo major: rostro et pedibus conspicue majoribus.

I cannot, however, venture to bestow a specific name, because, before the bird was submitted to me, a specimen was given by Mr. Bethune to Dr. Collins, who, I am informed, took it with him to England. If still without an appellation it might appropriately be named *Sterna bethunei*.

**Platalea regia**, Gould. (Royal Spoonbill.)

In vol. ix. of our Transactions, pages 337–338, I gave an account of the occurrence of this fine Australian bird at Manawatu. The specimen, for which I was indebted to the kind assistance of Mr. C. Hulke, is now in the mounted collection of the Colonial Museum. I am informed by Mr. W. Townson, of Westport, that another specimen was shot on the Buller River about January, 1892, and is still preserved in Dr. Gaze's collection.

**Phalacrocorax colensoi**, Buller. (Auckland Island Shag.)

Since writing the notes on the Auckland Island Shag which appeared in the last volume of our Transactions, I have had an opportunity of examining two more specimens (male and female). The male bird of these is without a crest, but has a broad irregular white dorsal patch, and the white alar bar long, narrow, and distinct. The female is also crestless, and exhibits only an indication of a dorsal spot in a few white feathers. The alar bar is very irregular, being represented in the left wing by only a few scattered white feathers. In both birds the white streak on the fore-neck commences within the angle formed by the crura of the lower mandible, and in-

* One of the measurements—the extent of wings—was furnished to me by the collector, having been taken when the bird was fresh; the other measurements are from the dried skin.

creases rapidly in width downwards towards the breast. These specimens, therefore, go to confirm the conclusions to which I had arrived from an examination of the collection made by Mr. Henry Travers.

**Diomedea regia,** Buller. (Royal Albatros.)

At the time of the last visit of the "Hinemoa" to Campbell Island the eggs of *Diomedea regia* were just on the point of being hatched, the embryo being well developed. This was at the end of February. The breeding season of *Diomedea exulans* on Auckland Islands is somewhat later, for on the same cruise the crew and passengers brought on board some four or five hundred eggs, all of which were fresh enough to be blown.

**Diomedea exulans,** Linn. (Wandering Albatros.)

The following cutting is from the *Sydney Morning Herald:* "With reference to a paragraph which appeared in a recent issue respecting the rescue of a seaman who fell overboard from the ship 'Gladstone' while on her voyage from London to this port, we have been supplied with the following interesting additional particulars by Captain Jackson himself: On the 24th October, at noon, whilst the ship was in latitude 42° and longitude 90° E., and going at the rate of about ten knots an hour, the cry of 'A man overboard' was raised. Captain Jackson and his chief officer, Mr. John Rugg, who were seated at dinner at the time, immediately rushed cut of the cabin and rounded the ship to. A boat, manned by four hands, was then lowered, and left the ship in charge of Mr. Rugg five minutes after the alarm was raised. The man was then out of sight, but the rescuing party pulled towards the spot where it was supposed he had fallen, and after some little time found him clinging to an Albatros, which he was using as a lifebuoy. As soon as the boat got within a few yards of him he let the bird go and swam to the boat, being apparently none the worse for his unexpected immersion. He returned on board smiling, and stated that just after he fell an Albatros swooped down upon him and made a peck at him, but he seized it by the neck and kept its head under water until he had drowned it, and then used it to preserve his own life in the manner already described. The boat was away about one hour. The sea was very rough at the time, and the wind was from the north-west. The most remarkable thing about this remarkable story is that the man, who could only swim a little, had heavy sea-boots on at the time of the accident, besides being encumbered with oilskins. The names of the crew of the boat were Messrs. W. Gilchrist, L. Mann, Richard Simpson, and John Murphy, the first two of whom are Sydney

men. The Albatros was the first that had been seen for a month."

**Diomedea salvini**, Rothschild. (Salvin's Albatros.)

On a recent visit to Wanganui I was invited by Mr. Drew, the curator of the museum, to examine and identify a live Albatros which had just come in. The bird proved to be an adult specimen (apparently a female) of *Diomedea salvini*. Mr. Drew gave me the particulars of its capture, which would seem to indicate that this bird is nocturnal in its habits. A party of fishermen in their boat, at 2 o'clock the previous morning—the night being starlight but without any moon—were waiting for the dawn, in order to fish for schnapper. They saw the Albatros hovering about them, and threw out a piece of bait on a line. The bird at once descended to the water, took the hook in its bill, and was towed on board. In this specimen the bill is grey with a yellowish unguis; the black pencilled lines and the yellow cartilage are very conspicuous.

**Œstrelata neglecta**, Schl. (Schlegel's Petrel.)

I find that in quoting Mr. Bethune in relation to this species (Trans. N.Z. Inst., vol. xxvii., p. 133), I rather overstated what he had said. He informs me that, although he saw many of these birds mated in the breeding season, as a matter of fact he "collected" only one pair—the specimens which I had the pleasure of exhibiting at the meeting of our society on the 5th September last. But, as far as he could observe, the two phases of plumage were always associated; so that my general argument is not affected in any way. But, as Mr. Bethune is a very careful observer, I am anxious that he should be reported with strict accuracy. On another point also I appear to have misunderstood him. This species, he assures me, does not deposit its eggs in a burrow, like so many of the other Petrels, but places them in an open depression on the surface of the ground.

**Œstrelata affinis**, Buller. (Mottled Petrel.)

The bird of the first year differs from the adult in being generally darker in plumage. The whole of the upper surface, the sides of the breast, the sides of the body, flanks and abdomen, dark slaty-grey, the feathers very minutely margined with paler. Chin pure white; lores, lower sides of face, fore-neck, breast, and under tail-coverts white varied with slaty-grey; on the breast in freckled wavy lines. All the median wing-coverts are stained with brown; the inner webs of all the wing-feathers pure white, as also are the larger under wing-coverts. Bill black; legs and feet yellowish-brown (in dried specimen).

**Puffinus bulleri**, Salvin. (Buller's Shearwater.)

A specimen brought from the Mokohinou Islands by Captain Fairchild in September last (in spirits), and presented by him to the Colonial Museum, has enabled me to describe the soft parts: Sides of the bill greenish, the ridge and hook brownish-black; feet yellow, the outer side of the tarsi and outer toes and a line along the base of the middle toe on its outer side blackish-brown. The bird proved to be a male, and the greenish colour of the bill is probably a sexual character, because there was no such appearance with my specimen (a female), although it was picked up fresh on the Waikanae sands. Mr. Sandager, in his description of *Puffinus zealandicus* (Trans. N.Z. Inst., vol. xxii., p. 291), which I have identified with this species, says that "the lower part of both mandibles is bluish, remainder black."

I may here correct a common error among local ornithologists—that of confounding *Puffinus* with Puffin, the two birds having no relation whatever to each other. The principal offender in this respect is Mr. Reischek, who has contributed some interesting notes on the various species of *Puffinus* to the pages of our Transactions, and persistently calls them "Puffins." Professor Newton, in his admirable "Dictionary of Birds"* —a book which should be on every ornithologist's shelves—gives the following explanation of this popular mistake: "The name 'Puffin' has been given in books to one of the Shearwaters, and its latinised form *Puffinus* is still used in that sense in scientific nomenclature. This fact seems to have arisen from a mistake of Ray's, who, seeing in Tradescant's museum and that of the Royal Society some young Shearwaters from the Isle of Man, prepared in like manner to young Puffins, thought they were the birds mentioned by Gesner (Hist. Avium), as the remarks inserted in Willoughby's "Ornithologia" (p. 251) prove; for the specimens described by Ray were as clearly Shearwaters as Gesner's were Puffins."

**Puffinus chlororhynchus**, Lesson (= *Puffinus sphenurus*, Gould). (Wedge-tailed Shearwater.)

I do not think I have yet put on record the following letter, received some time ago from Mr. W. M. Crowfoot, of Beccles, Suffolk:—

"My friend Mr. Dalgleish, of Edinburgh, draws my attention to the fact that, in the last edition of your most valuable book on the birds of New Zealand, in the article on *Puffinus griseus*, you state that my remarks on *Puffinus sphenurus* in Norfolk Island probably refer to *Puffinus griseus*. I think this is a mistake, as a skin of the Norfolk Island species

* Adam and Charles Black, London, 1894.

(which I at first thought was *P. griseus*) was sent to me by my correspondent, Mr. Metcalfe, and I forwarded it to Mr. O. Salvin for his inspection. He returned it to me as *Puffinus sphenurus* of Gould. I have since received the eggs of *Puffinus griseus* from New Zealand, and find that they are much larger than those of *P. sphenurus*, and of a different colour. My specimens of the egg of *P. griseus* measure 3in. by 2in. and 3¼in. by 2in. respectively, and are of a yellowish-white colour, whereas the eggs of *P. sphenurus* measure 2¾in. by 1¾in. and 2¼in. by 1⅞in. respectively, and are of a pure-white colour, just like those of *Puffinus anglorum* and *P. kuhli.*"

**Puffinus gavia,** Forst. (Forster's Shearwater.)

We have at length discovered the breeding-place of this species. I find that these birds resort in large numbers to Stephen Island, in Cook Strait, for the purpose of reproduction; and through the kind offices of Mr. Lyall, the lighthouse-keeper there, I have recently obtained six eggs. They are of a rather narrow ovoido-conical shape, perfectly white, and differing appeciably in size, the largest of the series measuring 2·45in. in length by 1·45in. in breadth, and the smallest measuring 2·20in. by 1·45in.

**Majaqueus parkinsoni.**

A specimen in the flesh (adult female) sent to me from Manawatu measured 18in. in length, and 47·25in. in extent of wings.

**Casarca variegata,** Gmelin. (Paradise-duck.)

Those of you present who have visited the Masterton fish-ponds cannot fail to have noticed a tame Paradise-duck, which has been an inhabitant of the place for several years. I have been assured by the curator that this bird is as useful as any watch-dog could be, for it sets up an unceasing clamour on the appearance of a stranger. Its affection for the keeper is most remarkable, for it will follow him everywhere and nestle about his feet in the most demonstrative manner, squatting on the ground with its neck outstretched and uttering all the time a sort of purring note of satisfaction. It has now a mate, and they have brought up a large brood of young; but previously to this it every season laid a number of unfertilised eggs, and then took to hatching-out a nest of domestic duck's eggs. The handsomely-striking plumage of this bird, coupled with its docility and readiness to breed in confinement, marks it out as being specially suitable for private ponds and ornamental waters.

A tame Duck of this species which I have at the Papai-

tonga Lake has attached itself in the same marked way to one of the domestics, but is shy and distant with every one else. I have remarked elsewhere* on the devotion of this species to its young, and the devices to which it resorts to draw intruders away from the vicinity of its nest. I have lately met with the following in the columns of a newspaper, and the record is worth preserving:—

"The following is a touching instance of the affection of birds for their young: Mr. Shalders informs the *North Otago Times* that, having been requested to obtain some young Paradise-ducks for the purpose of exchanging with the Acclimatisation Society of Victoria, he, while travelling with another up-country with a waggon and team, saw on a stream two parent birds and eight or nine young ones. On his essaying to capture some of these, the parent birds, like the Home lapwings, endeavoured, by feigning lameness, to decoy him from their young; but he captured three of them, and placed them in a small box on the waggon. They proceeded a distance of six miles and camped for the night, and on rising early in the morning Mr. Shalders's first care was to look after the young birds. On leaving the tent, however, he saw not far from the waggon a Paradise duck and drake, and remarked to his mate that he believed the birds had followed them. To ascertain if this were so, he took the little ducklings out and placed them on the ground some short distance from the waggon, and watched. They were almost immediately taken charge of by the drake, who made off with them through the mate-kauri in the direction of the river, rising every few yards in order, apparently, to let his companion see the course he was taking. The informant says he had not the heart to endeavour to recapture his prize, and he let them go as a tribute to the faithful care of the parent birds."

**Hymenolæmus malacorhynchus**, Gmelin. (Blue Duck.)

I received from Waikanae on Saturday, the 12th December, an adult pair of the Mountain-duck, with a bird of the first year, and a fledgeling from another brood. The last-mentioned accidentally hung itself in the wire-netting of its enclosure. The others were very shy at first, but soon adapted themselves to their new life, and took readily to their new diet of cooked potato and rice. When alarmed they uttered a loud whistling cry—especially the young bird; at other times their note was a low rasping one, like the sound produced by drawing an object quickly against the teeth of a large comb.

* "Birds of New Zealand," vol. ii., p. 266.

**Eudyptes chrysocome**, Forster. (Tufted Penguin.)

I am able now to add to my account of this species a description of the nestling from a specimen obtained at Dusky Sound.

Head, throat, hind-neck, and upper parts—that is to say, the surface that is coloured in the adult—covered with short sooty-black down, and the under-parts with short white down; bill whitish-horn colour; feet pale-brown.

In a more advanced chick—which is double the size of that already described—the down is even shorter, as if rubbed off, and the root-points of future feathers are disclosed, covering the surface in regular lines or series.

The young of this species differs from the adult in being appreciably smaller in size, and in having a whitish-grey throat; the long crests are absent, being represented by a tuft of feathers little more than ½in. in length, commencing immediately above the eyes and extending back 1½in. towards the occiput; pale lemon-yellow, with blue tips. Bill black, with reddish-brown tips.

**Eudyptes sclàteri**, Buller. (Sclater's Penguin.)

On the 25th February the "Hinemoa" brought from Antipodes Island four living examples of this species and ten of *Eudyptes chrysocome*. I am assured by the second engineer (who is a collector of birds) that the former always lays one egg and the latter two. *Eudyptes chrysocome* (= *E. filholi*, Hutton) is readily distinguishable from the other Penguins by its full crest of lengthened yellow feathers and its red eyes. Its home is Antipodes Island. But all those brought on this trip were birds of the first year, in which the crest was not yet developed. The examples of *Eudyptes sclateri* interested me very much, because they too were young birds, but somewhat more advanced, and just undergoing the first seasonal moult—throwing off the adolescent plumage and assuming that of the adult state. The young of this species has the plumage of the upper parts much duller, being mixed with brown, and the throat, instead of being black, is greyish-white, darker in some specimens than others. In one of the two which I secured the chin is white, and, this portion of the plumage not having moulted off, the bird presents a singular appearance, the white chin being very conspicuous. In the young bird the superciliary streak, which is broad and well defined, is white, instead of being golden-yellow, as in the adult. This species is found both on Antipodes Island and on Campbell Island. It has never, I believe, been found on the Auckland Islands. The species inhabiting that group is *Eudyptes antipodum*. The "Hinemoa" brought up one live

example of the last-named species for His Excellency the Governor. It has peculiar flat, button-like eyes.

A bird undergoing the first moult (February) presents the following features: Yellow facial streak broad and distinct, in a line with the nostrils, but at present extending only 1in. beyond the head; throat black, with well-defined lower margin, the old white plumage still adhering to the chin for the space of 1in. from the angle of the crura of the lower mandible, and giving a very peculiar appearance to the head. The old dark plumage is still clinging to the forehead, and the feathers are peeling off the flippers; but all the body-plumage has been completely renewed.

*Young of first year* differs from the adult in having the plumage duller, and the throat dark-grey, shading into the dark plumage on the sides of the head; broad superciliary streak of white springing not far from the angles of the mouth. At the first moult the white streak is replaced by a golden crest, the feathers of which project beyond the head. Bill dark-brown, and less robust than in the adult.

**Aptenodytes longirostris**, Scop. (King Penguin.)

On looking over a book of cuttings, I find that I omitted to notice in my "Birds of New Zealand" an interesting notice of this species which appeared in a southern paper in August, 1878: "A very handsome King Penguin was exhibited [at the Otago Institute] last evening. Professor Hutton said it was caught at Moeraki a short time ago, and that its existence proved that the King Penguin was really an inhabitant of New Zealand."

**Eudyptes atratus**, Hutton. (Black Penguin.)

A local ornithological event of some interest is the discovery of another example of the Black Penguin, described and named by Professor Hutton in 1875, from a specimen obtained at the Macquarie Islands, a group of sea-girt rocks lying about six hundred miles to the south-west of Stewart Island. For many years this was the only known example. It belonged to the fine collection of birds in the Otago Museum, and was lent to me by Professor Parker for the purpose of being figured in the second edition of my "Birds of New Zealand." A beautiful drawing of it was made by Mr. Keulemans, in association with *Eudyptes antipodum*, for the plate which faces page 294 in vol. ii. Unfortunately, the specimen itself was lost, with many other treasures, in the wreck of the "Assaye" on her return voyage to New Zealand. The present example, which also comes from the Macquarie Islands, is a somewhat larger bird, and is apparently quite mature; but apparently it had only recently moulted, as the

sulphur-coloured crests, which formed so striking a feature in the other, are only partially developed.

Apart from its black plumage, this species may be distinguished by its powerful bill, its very small hind-toe, and its long and rigid tail-feathers.

The true home of the Black Penguin has yet to be discovered. It no doubt lies to the south of the Macquaries, which seems curious, seeing that as we approach nearer to the South Pole the universal tendency in the birds is to assume whiter plumage. It can only be a straggler at the Macquarie Islands, because ever since the discovery of the type, in 1875, Captain Fairchild has made diligent search for it there during the periodical visits of the "Hinemoa" without ever seeing one.

The Black Penguin is the only uniform-coloured form in the whole group of these very interesting birds, and its present rarity adds very much to the value of the specimen.

The distribution of the various species of Crested Penguin is very curious. On the Snares *Eudyptes pachyrhynchus* is the only species to be found; on the Auckland Islands *Eudyptes antipodum*, which occurs also on Campbell Island; on the Bounty Islands *Eudyptes sclateri*; and on Antipodes Island both the last-named species and *Eudyptes chrysocome*. The habitat originally assigned to *Eudyptes sclateri* (the Auckland Islands), on the authority of a live one sent to the Zoological Society, was evidently a mistake. Going still further south, we find on the Macquarie Islands the magnificent King Penguin (*Aptenodytes longirostris*), the Royal Penguin (*Eudyptes chrysolophus*), the Rockhopper (*Pygoscelis tæniatus*), and the Black Penguin (*Eudyptes atratus*), of which, as already remarked, only two examples have been recorded.

On the New Zealand coasts both *Eudyptes pachyrhynchus* and *E. sclateri* are occasionally met with.

**Apteryx oweni**, Gould. (Grey Kiwi.)

One of my correspondents, writing from the Karamea Saddle on the 6th April, says, "I expected to find Kiwis very plentiful here, but I have not yet obtained one, although I have been camped in these woods three months. The forest is nearly all of red-birch, and, owing to the dampness of the woods, the ground is spongey and mossy, with an abundance of worms, which constitute the favourite food of this bird. The District Surveyor, who has an excellent retriever, has caught only two during the last four months. Woodhens, too, are very scarce. I have collected a few of the brown-legged species. I have preserved them, and will send them to you on my return to Nelson. On 1st April I came across a family of the red-legged species—male, female, and two young. I cap-

tured the two old birds and one young one, all of which I have preserved. The legs of the old birds were quite as red as those of our Wood-pigeon. The most plentiful bird in these woods is the little Rifleman. I have seen only one Saddleback, which I managed to secure. I am camped at an altitude of 3,300ft., and have not as yet seen any Tuis or Pigeons. I cannot say that I have actually seen any stoats or weasels here, but they are known to be on the Dart River and on the Rolling River, about fourteen miles from here." Once in the district there is no withstanding their spread, and with it the absolute extinction of these vanishing species. Nothing can save them.

**Apteryx haasti,** Potts. (Haast's Kiwi.)

Since my last paper on this subject I have had the opportunity of examining another egg of this rare species, taken from a Kiwi's underground nest in the Heaphy Ranges. It is broadly elliptical in shape, measuring 4·75in. in length by 2·75in. in breadth, and is of a pale greenish-white hue. It was obtained in the early part of December, 1894, and was perfectly fresh.

I am also in a position now to give the description of the young: The whole plumage blackish-brown, paler and inclining to grey on the under-surface, and having a distinctly spotted character. This is produced by each feather having a single transverse band of pale chestnut-brown on its apical portion, with the minutest tip of the same colour. These spotted markings are entirely absent on the head and upper part of the neck, which parts are uniform greyish-brown, paler on the sides of the head. Tarsi and toes blackish-brown; claws black.

**Apteryx occidentalis,** Rothschild. (Larger Grey Kiwi.)

I have also had an opportunity of examining two eggs of the large Grey Kiwi, from the same locality, the male bird having been taken from the nest sitting on the eggs. These also are broadly ellipitical and pale greenish-white. The larger of the two measures 4·6in. in length by 2·5in. in breadth. The other egg is about one-sixteenth of an inch shorter, and is much soiled by contact with the bird's feet.

## ART. XXXII.—*On the Occurrence of the Nankeen Kestrel of Australia* (Cerchneis cenchroides) *in New Zealand.*

By Sir WALTER L. BULLER, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 21st August, 1895.*]

IN November last I received a note from Professor Hutton informing me that a specimen of the Nankeen Kestrel had been shot in New Zealand, and advising me to write to Mr. Cuthbert Studholme for particulars. I accordingly did so, and promptly received the following letter in reply:—

"The Waimate, Canterbury, 13th November, 1894.

"DEAR SIR,—

"On behalf of my brother I beg to acknowledge the receipt of your letter about the Australian Kestrel. I shot the bird about five years ago close to the house; it was amusing itself by chasing the common hawks away from the carcase of a dead sheep. My two youngest brothers had seen the bird flying about here for fully a week before it was shot. . . . "Yours sincerely,

"E. C. STUDHOLME.

"Sir Walter Buller, Wellington."

I have not yet seen this bird, although Mr. Studholme has kindly promised to give me an opportunity of examining it. Professor Hutton informs me that it is a female.

More recently a specimen has been shot on Portland Island. It was sent on the 16th April by Mr. J. R. Dickson, the lighthouse-keeper, to the Colonial Museum, and was handed to me by Sir James Hector for identification. Mr. Dickson, in forwarding the specimen, says: "The body of the bird was very fat; its crop contained crickets and grasshoppers. The iris of the eye was very dark brown; pupil black. It was very shy when perched, but not so on the wing. Its flight was much like that of the Quail-hawk. It was shot on the 6th April, 1895."

This bird, too, was a female, and, judging by the blueness of the upper tail-coverts, an old one.

# Art. XXXIII.—*Notes on some Species of New Zealand Birds.*

By J. Walling Handly.

Communicated by Sir Walter Buller.

[*Read before the Wellington Philosophical Society, 21st August, 1895.*]

**Harrier** (*Circus gouldi*, Bonap.).

The harrier is the most plentiful and generally-distributed species of rapacious bird in this district, appearing to be as equally at home on the settler's clearing as when coursing over the wide tussocky uplands on the back-stations. Of late years it has sensibly diminished, partly owing to the depredations of rabbiters, who seem to make a general practice of exterminating all birds that may unwarily frequent their preserves, in order to protect their own particular quarry.

An instance illustrative of the acute olfactory sense of this species came under my notice about two years ago. A gentleman of my acquaintance, who was experimenting with a new process of rabbit-trapping on a station near Blenheim, placed a dozen rabbits in the station woolshed, intending to forward them to the rabbit-factory the succeeding morning. Illness, however, prevented him from visiting the locality for a few days, when he perceived the roof of the shed, over the part where the rabbits were hanging, crowded with harriers, vulture-like, silently waiting for their prey.

**Sparrow-hawk** (*Hieracidea novæ-zealandiæ*, Lath.); **Bush-hawk** (*H. ferox*, Peale).

Both tolerably numerous.

**Morepork** (*Spiloglaux novæ-zealandiæ*, Gml.).

Common; an occasional specimen may often be heard quite close to town. Some time ago one was caught while attempting to capture a caged goldfinch hanging under a verandah here.

**Dollar-bird** (*Eurystomus pacificus*, Lath.).

An occasional straggler from Australia.

**Kingfisher** (*Halcyon vagans*, Lesson).

This splendidly-coloured bird may be regarded as one of our commonest birds, being generally found in all suitable localities throughout the province. During the autumn and winter months they congregate in considerable numbers;

twenty or thirty specimens may often be noticed within quite a small radius.

**Parson-bird** (*Prosthemadera novæ-zealandiæ*, Gml.).

A rapidly-diminishing species.

**Bell-bird** (*Anthornis melanura*, Sparrm.).

The bell-bird, familiarly called the "mocker," still holds its own, and is to be met with in most unlikely places, frequenting alike the scant open scrub and *Phormium* along the sea-shore, and blind gullies winding amid arid hills, as well as the virgin bush. Along the bridle-track leading from Picton to the Grove, during the Easter of 1894, it was particularly abundant—the bush seemed to swarm with them; but upon reaching the Mahakipawa goldfields, but a few miles distant, the following day, none were observed. A nest now in my possession was found built in and over that of a song-thrush (*T. musicus*).

**Blight-bird** (*Zosterops lateralis*, Lath.).

Very common.

**Bush-wren** (*Xenicus longipes*, Gml.); **Rock-wren** (*X. gilviventris*, Pelz).

Both species are now principally restricted to the back-ranges, the former predominating.

**Rifleman** (*Achanthidositta chloris*, Sparrm.).

Numerous in the Sounds district.

**Yellow-head Canary** (*Orthonyx ochrocephala*).

Common, though never associated together in large flocks.

**Fern-bird** (*Sphenœacus fulvus*, Gray).

Seldom obtained.

**Grey Warbler** (*Gerygone flaviventris*, Gray).

Very common; frequenting the gardens and hedgerows during the winter months.

**Brown Creeper** (*Certhiparus novæ-zealandiæ*, Gml.).

Common.

**Yellow-breasted Tit** (*Petroica macrocephala*, Gml.); **South Island Wood-robin** (*P. albifrons*, Gml.).

Both very common.

**Ground-lark** (*Anthus novæ-zealandiæ*, Gml.).

The introduction of ground-vermin and the laying of poisoned grain for small birds are the factors largely responsible

for the rapid diminution of this bird during recent years. It is, however, to be met with in considerable numbers in many localities—more especially in the Awatere district; and I have noticed in Picton several small flocks running along the grass-covered streets of that prettily-situated seaport town.

**Pied Fantail** (*Rhipidura flabellifera*, Gml.); **Black Fantail** (*R. fuliginosa*, Sparrm.).

Common; the former species occurs in the ratio of six to one of the latter. I have seen an albino, having a wing pure white, the remaining plumage being of the ordinary colouring.

**Orange-wattled Crow** (*Glaucopis cinerea*, Gml.).

Occurs in the neighbourhood of Mount Riley.

**Saddleback** (*Creadion carunculatus*, Gml.).

The range of the saddleback is yearly becoming more circumscribed, and it is now confined to a few out-of-way localities, such as Tophouse, on the road to Nelson, and the Sounds district, where it is rare and widely distributed.

**Red-fronted Parrakeet** (*Platycercus novæ-zealandiæ*, Sparrm.); **Yellow-fronted Parrakeet** (*P. auriceps*, Kuhl); **Orange-fronted Parrakeet** (*P. alpinus*, Buller); **Lesser Red-fronted Parrakeet** (*P. rowleyi*, Buller).

The red-fronted bird is the most plentiful, being generally to be met with in all suitable localities. During the year 1888, the year of the unprecedented invasion of native rats, hundreds of parrakeets, particularly the first two species, haunted the neighbourhood of the villages adjacent to the bush and made themselves obnoxious to orchardists, in many instances entirely stripping the trees of their fruit.

In caged specimens of *P. alpinus* the articulation is very indistinct.

**Brown Parrot** (*Nestor meridionalis*, Gml.).

The kaka was at one time very abundant. A spot was lately pointed out to me along the road to Picton where in former days the natives camped for weeks in order to snare them for winter consumption, where now, alas! not one is to be found within many miles.

**Long-tailed Cuckoo** (*Eudynamis taitensis*, Sparrm.); **Shining Cuckoo** (*Chrysococcyx lucidus*, Gml.).

The first visitants herald their arrival about the third week in October; and during the latter part of November and December, when the main body appears, they are very plentiful, numbers frequenting the plantations near town, depending principally for their means of subsistence upon their persistent

robbery of the nests containing eggs and young of several species of acclimatised birds. The latest record of their occurrence is 26th March.

Owing to its general resemblance at a distance to the greenfinch (*C. chloris*) the shining cuckoo is, I believe, in numberless instances mistaken for that species. Comparatively few people here seem to be acquainted with it, though very common.

**Wood-pigeon** (*Carpophaga novæ-zealandiæ*, Gml.).

Irregularly distributed; albinoes are often shot.

**South Island Kiwi** (*Apteryx australis*, Shaw); **Grey Kiwi** (*A. oweni*, Gould).

Both species have now become very rare. Individuals of the latter species are now confined to the high precipitous hills bordering Cook Strait, notably Port Underwood, from where a few are occasionally procured. The back ranges of the Wairau Valley, the Wakamarina, Mahakipawa, and Waikakaho Goldfields, as well as portions of forest-country within the confines of the Queen Charlotte, Pelorus, and Kenepuru Sounds, are the haunts of the main remnant.

**Eastern Golden Plover** (*Charadrius fulvus*, Gml.).

A specimen was shot at the Wairau bar early in January. I heard the particulars of its capture some days after it was shot, and endeavoured to secure it, but the shooter had in the meantime eaten the body, no doubt with satisfaction to himself, but giving me cause for regret, as I do not possess a specimen.

**Dottrel** (*Charadrius bicinctus*, Jard.).

The dottrel is very numerous along the sandy shores of the southern portions of the province, but rare in the Sounds. Throughout the year considerable numbers habitually frequent the river-beds and stony pastures far inland. While crossing the Taylor River-bed on horseback one evening I noticed a dottrel flying along, as if wounded, a few yards in advance of a retriever; the dog entered into the chase with spirit, coursing up and down the river-bed until it seemed perfectly tired, and was returning to the road again when the dottrel, observing the direction it was taking, flew again in front of it and repeated its antics, until, having, no doubt, betrayed it past the spot where its eggs or young were concealed, it mounted high in the air and wheeled back again.

**Crook-bill Plover** (*Anarhynchus frontalis*, Quoy et Gaim.).

Resorts to the mud-flats at the Wairau bar, and I have also met with it on the Awatere and Spring Creek river-beds.

**Pied Oyster-catcher** (*Hæmatopus longirostris*, Vieill.); **Black Oyster-catcher** (*H. unicolor*, Forst.).

Both frequent the extensive mud-flats in various parts of the Sounds, marshy situations far inland as well as round the coasts; they are very plentiful at Port Underwood.

**White Heron** (*Ardea alba*, L.); **White-fronted Heron** (*A. novæ-hollandiæ*, Lath.); **Blue Heron** (*A. sacra*, Gml.).

The white heron, or crane as it is generally called locally, is, owing to its conspicuous appearance, the most generally heard-of species. Of late several specimens have been obtained; the last one—a remarkably fine bird—I saw mounted in a window here was obtained at the Wairau Pa by a native. Individuals oftentimes haunt for a considerable time the mud-flats at the junction of the Opawa and Wairau Rivers and their adjacent lagoons, and generally manage to elude capture. My father observed a beautiful specimen some years ago perched on the topmost bough of a weeping-willow overhanging the Wairau River, near the Wairau Pa. The natives all turned out to observe the stranger, one old man indicating a spot some distance up the river where in former days they resorted in numbers.

**Bittern** (*Ardea pœciloptila*, Lath.).

Numerous.

**Sandpiper** (*Limnocinclus acuminatus*, Horsf.); **Godwit** (*Limosa baueri*, Naum.).

The godwit, known by the local trivial appellation of snipe, and shot and eaten as such, is plentifully distributed along the coast and estuaries of our rivers during its summer sojourn.

**Pied Stilt** (*Himantopus leucocephalus*, Gould); **Black Stilt** (*H. novæ-zealandiæ*, Gould).

Both species occur sparingly, and in localities far apart.

**Knot** (*Tringa canutus*, L.).

Pelorus Sound.

**Southern Woodhen** (*Ocydromus australis*, Sparrm.).

A pure-white albino was captured by a party near the Top-house, on the road to Nelson, and kept alive by its owner as a curiosity for a considerable time, until it began to assume the ordinary brown colouring, when the owner had it killed and mounted.

**Striped Rail** (*Rallus philippensis*, Linn.).

Now rare and widely distributed. While at Kenepuru at Christmas a young one was captured, and several others were reported from several localities in the same sound.

**Swamp-crake** (*Ortygometra affinis*).
Very rare.

**Swamp-hen** (*Porphyrio melanotus*, Linn.).
A rapidly-diminishing species. Albinoes are frequently reported.

**Paradise-duck** (*Casarca variegata*, Gml.); **Little Teal** (*Querquedula gibberifrons*, Müller); **Brown Duck** (*Anas chlorotis*, Gray); **Grey Duck** (*A. superciliosa*, Gml.); **Shoveller Duck** (*Rhynchaspis variegata*, Gould); **Blue Mountain-duck** (*Hymenolæmus malacorhynchus*, Gould); **Black Teal** (*Fuligula novæ-zealandiæ*, Gml.).

The paradise-duck was formerly more numerous in this province than, owing to the progress of drainage and the consequent extension of agriculture, it is at present, though still by far the most abundant species.

Lake Grassmere, though little more than a lagoon, about three miles in diameter, situated along the coast between the Awatere River and Cape Campbell, and Lake Rae, situated in the open country between the Awatere and Clarence, and generally known as the Salt Lakes, are now its chief haunts. In the early days very heavy bags were obtained.

The Wairau lagoons, which cover an area of country equal to eight square miles, was in the early days alive with them during the shooting season, and "shootists" from all parts were there to be found congregated, with punts, swivel-guns, and every other gun guaranteed to kill. The result was that the birds were slaughtered by thousands to supply the Wellington market. This went on for years, till the local acclimatisation society prayed the Governor to proclaim it a protected area. This was granted, and now large flocks may be seen disporting themselves on the placid waters.

Of the remaining species none require any particular notice. The shoveller, or spoonbill, as known locally, is most generally found frequenting the two chief lagoons before mentioned. I recently examined a stuffed albino shot in the Awatere the general colouring of which resembled that of a silver-grey Hamburg fowl, the wings and neck being of a beautiful mottled silvery-grey. The bill was abnormally large and deeply coloured.

The range of the blue mountain-duck is restricted to the foamy mountain-torrents amid the lonely fastnesses of the Clarence, and the Kaikouras, although a few frequent the Awatere.

The little teal and black teal are the rarest species; and of the remaining species the grey duck is the commonest.

**Crested Grebe** (*Podiceps cristatus*, L.).

Very rare; I have heard of but few occurrences.

**Black-backed Gull** (*Larus dominicanus*, Licht.).

Everywhere plentiful. A large breeding-colony exists at the mouth of the Awatere River, from whence I recently obtained sixteen beautifully-marked eggs.

**Mackerel Gull** (*Larus scopulinus*, Forst.).

Not so numerous as the previous species.

**Caspian Tern** (*Sterna caspia*, Pallas); **Sea-swallow** (*S. frontalis*, Gray); **Common Tern** (*S. antarctica*, Forst.); **Little Tern** (*S. nereis*, Gould).

All numerous. The sea-swallow is called by the Sounds fishermen "barracouta-bird."

**Black-eyebrowed Albatros** (*Diomedea melanophrys*, Boie).

Mr. Joseph McMahon, of Kenepuru, secured a skeleton found on the Kenepuru beach, and by a careful comparison of its mandibles with those illustrative of this species in the Auckland Museum he was enabled to correctly determine the species.

**Diving-petrel** (*Halodroma urinatrix*, Gml.).

Plentiful.

**Mutton-bird** (*Procellaria tristis*, Forst.).

Most numerous off Jackson's Head.

**Cape Pigeon** (*Procellaria capensis*).

Often observed along the coast.

**Dove-petrel** (*Prion turtur*, Soland.).

Abundant.

**Gannet** (*Dysporus serrator*, Banks).

Abundant.

**Black Shag** (*Phalacrocorax novæ-hollandiæ*, Gould); **Frilled Shag** (*P. melanoleucus*, Vieill.); **White-throated Shag** (*P. brevirostris*, Gould); **Pied Shag** (*P. varius*, Gml.); **Spotted Shag** (*P. punctatus*, Sparrm.).

Owing to its special relish for trout, the black shag has become a marked bird to the local disciples of Isaac Walton. Considerable colonies are to be met with all round the coasts. At Port Underwood they are said to be particularly numerous. In the Kenepuru Sound, owing to continuous molestation, it has now become scarce.

The frilled shag is, owing to its cautious habits, called the "duck-scarer" by the sportsmen living in the above-mentioned Sound.

The spotted or king shag is apparently yearly increasing its range; the rocky islets off Jackson's Head have long been frequented by considerable numbers. Two immature birds brought to me from White's Bay were, so their captor said, "jist gittin' their toppins." It also frequents the sea-shore near Cape Campbell, the Flaxbourne Station, as well as a station to the south of Cape Campbell—localities all widely separated.

**Crested Penguin** (*Eudyptes pachyrhynchus*, Gray).

Several specimens during recent years have been secured in various localities. Two specimens now on sale here were captured in Queen Charlotte Sound.

**Blue Penguin** (*Eudyptula minor*, Forst.); **Little Penguin** (*E. undina*, Gould).

Both numerous.

## ART. XXXIV.—*Bird-life on a Run.*

By H. GUTHRIE-SMITH.

[*Read before the Hawke's Bay Philosophical Institute, 12th August, 1895.*]

THE natural history of New Zealand at present is in a transition stage. The importation of new animals, the wide distribution of firearms, the felling and stocking and draining of country are all important factors in the great alterations that are occurring hourly in our colony. The indigenous creatures are being subjected now to a competition unknown before. In every direction they have to face changed surroundings, and this we shall see more or less in the paper I am about to read.

The natural history of New Zealand, however, is too large a theme to be treated to-night, and I shall confine myself to a branch of this interesting subject—bird-life on a run. I may state that the run here spoken of lies about twenty-five miles north-east of Napier. The nearest point lies about seven miles from the sea. There is a lake about three miles long in the centre of the property. The hills are limestone, and rise to about 1,600ft. In one part of the run there is a strip of pumiceous country. Some of the land is still in bush, some in fern, some in swamp and raupo and flax. For years,

however, most of it has been grassed. When this block was taken up fifteen years ago very little work had been done there. The place was mostly in its natural state of fern, bush, and swamp. It has been easy, therefore, to note the arrival of foreign species, the disappearance and growing scarcity, and sometimes, though more rarely, the increase of the indigenous birds.

As the British and Australian birds are still comparative strangers, they may be given first place. Even when the run was first taken up larks and Australian swans had preceded us. The English lark, however, cannot here boast of his early hours. Those who dwell in tents hear the harsh screech of the kaka and the liquid notes of the tui long before the lark has stirred. When the silence of night still reigns over the bush, and the hushed murmur of the forest-brooks alternately grows and fades in the ear, it is the brown parrot and the parson-bird that first enliven the expectant woods. It is only later, when the shepherds brush from the dew-soaked scrub the hanging drops, and the last stars pale and fade, and the steam of the little waterfalls rises on the sharp, keen morning air, that the lark sings in the grey dawn.

Although it would be natural to expect the black swan should be fairly numerous on our considerable sheet of water, this is not the case. Whether because there is no feeding in the lake, or for some other reason, swan have never been plentiful. Indeed, though so near the Napier lagoons, these birds may here be actually called rare. Sometimes in the dawn their music may be heard high overhead, and sometimes for a few days a brace will remain. The absence of reeds and raupo-beds seem to be distasteful to many of our water-fowl. A brace of Australian magpies in 1888 took up their abode in a clump of native bush close to the homestead. Unfortunately they were shot, and no others have taken their place. At a neighbour's run a pair of these birds were the terror of travellers going along the Wairoa Road. The shepherds' main track, too, passed close to their nesting-tree, and it was amusing to notice the woebegone appearance of the collies as they neared the fatal spot. On one occasion one of these magpies actually knocked the hat off a specially-obnoxious swagger who happened to be travelling up the coast.

Birds do not, however, always come in pairs; indeed, from the fact that the few rabbits killed at intervals of years in this part of the coast have been forlorn bachelors, it seems not unlikely that the earliest arrivals on new ground are outcasts driven from the parent colony. Many years ago, during two successive springs a minah appeared on the place. It used to sit disconsolately outside the fowl-yard seeking to chum up with the hens, who rather scornfully rejected its advances.

For the last three seasons one or two brace of minahs have appeared. This year, as the birds were evidently looking for a building-site, I had a box put up in one of the pine-trees. It was an open box, not at all adapted to the habits of the bird. However, in spite of this, a nest was built and eggs laid. I believe that normally these birds build in holes of trees or stacks, or under eaves of houses; at any rate, they attempted to remedy the defects of their open box, and the eggs were found covered with willow-leaves. Whether to hide the pale-blue eggs or whether to shield them from the sun, there is something in this action that seems almost to transcend what we term instinct. I recollect the arrival of the first sparrows, and how pleased we were to hear their merry chattering. How dependent on man and his requirements are the numbers and habits of the inferior creatures is well illustrated by the history of our sparrows. They, too, like man, are dependent on events taking place at the other end of the world, and for which they are in no degree responsible.

The earliest improvements on the run were done by white men, and while they were resident on one spot our sparrows increased and multiplied. At a later period all improvements were stopped, and the sparrows decreased. When work was again started, for various reasons native labour was employed, and the men were camped out. Sparrows abhor such temporary quarters as tents, yet their numbers began again to swell. Later again they increased enormously when oats were grown, rising in clouds from the grain and filling the pine-trees with their untidy nests. The development of the frozen-meat industry, however, was a serious blow to their interests. We found then that turnips were the best-paying crop, and ceased grain-growing. At present only a few couples reside at the homestead and woolshed.

About six years ago a cock goldfinch appeared in spring. I used to see it as I went over to the woolshed day after day. It was always alone, and, as none of us observed young birds later in the season, I do not think the female was sitting. Next year, however, it reappeared about the same time and on the same spot, this time with a wife. Goldfinches are now very common. Their plumage of red and gold ornaments the autumnal thistle-tops. In the garden and lawn they may be noticed gathering their food from the sow-thistle, and bending the hollow stems of the seeding dandelions. Yellowhammers and linnets are pretty numerous.

Five years ago the first thrush was heard, and now they have considerably increased. They do not seem to particularly haunt the homestead, but live in patches of scrub in various parts of the run. Thrushes do not seem to do very well in Hawke's Bay—at least, I have not often heard them

in the shrubberies, or seen them on the lawns. For the last three years during winter flocks of starlings have been noticed on the run.

In one small patch of bush a peahen has lived alone for three or four seasons. I believe there are no other examples of this breed within twelve miles.

A blackbird has been heard in the Matahaura Gorge, on the Napier–Gisborne Road.

Of game birds I have seen pheasants, partridges, Australian and Californian quail. The partridges have utterly disappeared, probably also the Australian quail. The pheasants and Californian quail still fight it out with rats, cats, dogs, weasels, wekas, and lastly man. In all, fifteen species of imported birds have been noticed on Tutira up to July, 1895.

Of the 176 New Zealand birds enumerated by Sir Walter Buller, no less than thirty-five have been observed on the run. Taking into consideration the species only to be found in the South Island, the sea-birds, the Chatham Island representatives, and these Australian birds, which are really but visitors, I think the number is large. As out of the nine ducks native to the Island seven have been observed on the run, the swimmers may first be considered.

The paradise-duck, once a pretty frequent visitor, now appears but rarely. The traffic and the shepherds and barking of dogs may be the cause, though not altogether, for on two occasions I have seen a brace of these birds not sixty yards from the Petane Hotel on a paddock close to the road. This handsome sheldrake offers a good example of double sexual selection; and of all birds that simulate lameness the paradise-duck does so most perfectly. Throughout the Mackenzie Country, in the South Island, this bird is very common. At the head of Lake Tekapo, under the glaciers and streaks of perpetual snow, while angling I have watched with interest the stratagems used to decoy me away from the eggs or ducklings, the bird now trailing a broken wing, now dropping on an injured leg. On the smaller pools and lakelets the brown duck is pretty numerous. He is a tame little fellow, and takes to flight with some unwillingness. The grey duck we have also, but few of these birds abide with us. Even when shooting is going on at other spots the grey duck does not stay.

Last year a shoveller rested for a short time on one of the smaller lakes. About seven years ago, after a violent southerly gale, a brace of blue ducks appeared on the lake. Although the "whio" or "whistler," as the natives call it, is fairly plentiful, this is the only occasion it has been seen away from the haunts peculiarly its own—the rushing, shadowed creeks half-blind with fern and koromiko. I have given orders that

this delightful bird shall be in no way molested, for there are few sounds more characteristic of wild New Zealand than the startled, half-indignant whistle of the mountain-duck. Dipping from the summer's sultry heat into some deep fern-feathered gorge, I have often paused to watch him. The little waterfalls dash into diamonds on his slate-blue plumes. He is thoroughly at home in the bubbling champagne pools. Where the swift stream shows every polished pebble clear he can paddle and steer with ease.

Throughout the year there are numbers of the scaup, or black teal. I have been surprised at what the historian of our New Zealand birds says of its powers of flight. He remarks, "Its powers of flight are very feeble; it takes wing with reluctance, and never rises high in the air." At a shooting party, when guns have been stationed round the lake, and boats worked for a couple of hours, I have seen nearly every black teal leave the lake. Gathering into flocks, they would rise as high as three hundred yards, and, circling higher and higher, disappear. The birds did not usually reappear for several days. Of the white-winged duck a single specimen was procured last year.

The skies of New Zealand would be very different without the harrier. Over every acre of the run he hunts industriously, flapping lazily over the fields of fern, or sailing high in air, a patch of brown against the blue. We have also the fierce and bold little sparrow-hawk. I have seen one of them strike a chicken at the very kitchen-door. In the course of their strong low-level flight they seem to know no fear, and disdain to move aside even for man, passing with hardly a swerve close above his head. Often when mustering sheep the scared collies have returned to me hunted back by this resolute little hawk. He builds in ledges of cliffs, and the great harrier, when near his nesting-place, is furiously assailed. The little hawks utter a kind of neighing scream, for usually both male and female attack the intruder. Circling above their foe they swoop upon him, while the harrier, hard-pressed, turns completely over on to his back, stretching out in defence his terrible talons.

Of the two native owls I have never heard the laughing cry of the almost extinct whekau. The solemn little more-pork is pretty common. As a rule he rests from hunting and rapine during the day; still, even in the light he will throw no chance away. Mr. Sidney Brandon, who is an accurate observer, and to whom I am indebted for help in this paper, noticed on one occasion a flight of blight-birds settle within reach of a morepork, who instantly reached out a claw and seized one of them.

During late autumn and winter the kingfishers begin to

come in from the outlying parts of the run. The head and long projecting beak give them rather a jockey-like appearance. During heavy rainfalls many of these birds congregate in the garden. There, selecting the low bough of an orchard tree, they wait for the drowned or wandering worms. The moral character of the kingfisher does not seem altogether above reproach: on one occasion I saw a small chick killed, and for no apparent purpose. The kingfisher will also kill canaries as they cling to the wire of the aviary.

A rather remarkable instance of aberration of instinct in the kingfisher came under my notice three years ago: the bird had begun to bore into a rotten stump not more than a foot or so in width, and therefore quite unsuitable for nidification. Our kingfisher's eggs are as round as those of the British species.

Of the honey-eaters we have two—the tui and the wax-eye or blight-bird. To those who have been once only in our New Zealand woods it is unnecessary to dilate on the tui. Throughout the years, almost at any hour, even through the warm, light summer nights, his pleasing notes blend with the unceasing rustle and stir of leaves and the sound of the wind in the tree-tops. In its wild state even the tui is an accomplished mimic, taking off the squeal of the wild pigs particularly well. Mr. Brandon tells me that not infrequently his collies have mistaken its imitation of a shepherd's whistle for the genuine article. One nest I examined was built of small branches of manuka, lacebark, lichen and mosses woven together, while the delicate, white, rather long eggs lay in a thick bed of the brown glaucous hair of the tree-fern's crown; a second was built entirely of the little jagged branches of the lawyer, and lined with bush-grass and a few feathers.

The little blight-bird's history in the North Island has been fully given by Sir Walter Buller. With us it is one of the native species that has increased greatly of late years. These birds roost in large flocks in the fern—at any rate in summer. Often I have startled them out of their cover at dawn. In spring, when nestling, they are exceedingly tame, and do not seem in the least alarmed or shy, even of an observer within 6ft. of their nest. They will hop about quite unconcerned, or, sidling up, will press close to one another like love-birds. A glance at one of their nests will reveal the great alterations that have taken place in the natural history of New Zealand within the last few years. First of all, the bird itself has only lately come to the North Island; and one nest I got was composed of Yorkshire-fog grass, a few fowl-feathers, and hair of horses and cattle—every material alien to the colony. Few sights are prettier, I think, than to watch the wax-e[illegible] threading its way through the prickly mazes of a box-thorn

hedge—the colours of the bird, the bright scarlet berries, and the deep verdure of the leaves forming a pleasing picture. Ordinarily these birds have a joyous twitter. In early dawn, however, when waiting for the sheep to appear and amusing myself by birdnesting, I have heard them uttering what I can only term a whisper-song. The notes are so very low that they could not be heard further than a few feet.

In the many small raupo-beds around the lake the little fern-bird may be heard rustling. "Fern-bird" is rather a misnomer nowadays, for, whatever the habit of the utick may have been, I have never yet, though riding over hundreds of miles of fern-country in the course of the year, observed the bird in this kind of herbage. Ordinarily this species is very shy; but in spring the male loses to some extent his timidity. He will then, regardless of the presence of man, mount to the very top of a flax-stick, climbing up in little runs, like a mouse or a house-fly. His tail is all the while bent in towards the stem. Indeed, like a young bird swung in the air, the utick seems to use his tail for balancing.

Among other small birds we have the grey warbler, whose delicate pensile dome-nest is built of moss, then thistledown, and lastly feathers. The pied tit also is to be found on the run: it is one of our rarest birds. The pied fantail, on the other hand, is one of our commonest species, and adds another charm to our native woods. He does not like the wind, but in the forest-paths, when the chequered light or shade hardly moves on the nibbled grass, he unceasingly flutters and flits. Along the bubbled brooks he dances above the drooping koromiko and tutu. This fairy of our bush is, however, a hardy little creature. Often I have seen him hunting for flies in pelting rain, when the boles of the great pines were water-pipes, and from the patter and splash of the big drops a gritty mist arose from the soaked earth. He never remains for any length of time in the air, after a short flight or hover alighting for an instant and then darting off once more. I am inclined, after a good deal of observation, to think that, at any rate on some occasions, he deliberately furthers his work of securing food by perching on outlying boughs and thereby shaking out the minute insects.

Another of our native birds is the pihoihoi, or ground-lark.

Once or twice I have noticed parrakeets, but at too great a distance to be sure of the variety. We have the brown parrot too. On some gaunt and ghostly forest monarch, standing barked and battered above the fallen bush, the kaka may be heard harshly denouncing the spoilers of his sylvan home. Besides the felling of timber and subsequent bush-fires, the English bees are also affecting the chances of the kaka in the

struggle for existence. Twice in taking wild swarms I have found egg-shells among the broken bark and dust. On several occasions the whekau, or laughing-owl, has even been stung to death, and this may happen to the kaka also. There is no doubt, at any rate, that the bee has often usurped his hollow tree.

Both our cuckoos arrive about the first week in October. The long-tailed species is rare, but the shining-cuckoo may be heard everywhere during the early summer months. It loves, like the tui, to perch on the top of some bare bough. From beneath I have often watched the music brew and bubble in its bronze-brown throat. This cuckoo fairly swarms in the bush between Mahia and Gisborne. Upon one occasion I heard the pipiwarauroa whistling within a few minutes of midnight.

Twelve years ago I knew a couple of natives shoot eighty pigeons in a day. Their numbers have sadly fallen off since that time; not a quarter that number are now killed during the whole season. They are easy to shoot, and good to eat; but it seems a pity that these confiding birds should, from these very qualities, be unfit to survive.

One of the rarest birds, perhaps, that has ever visited the station is the kotuku, or white heron. Buller describes it as wild and shy; yet upon its first appearance here I rode directly beneath it. It was on the top bough of a large willow, some 50ft. or 60ft. from the ground, and perhaps because I had no gun, or because it was tired after a long flight, I was allowed to admire at leisure. A few hours later a native fired at the bird. We saw it once again, sailing up the lake, snow-white between the blue of water and sky. Certain feathers of the kotuku were in old times used to ornament the heads of chieftains, and the natives about us have a tradition that one of these white herons after being seen at the Tongoio lagoons will next appear at Tutira. On two other occasions we have had visits from these graceful birds.

Another smaller variety of the heron family—the bittern—is more common. Sir Walter Buller remarks concerning this bird, "If unmolested it may be observed stalking knee-deep in the water in search of food, with its neck inclined forward, raising its foot high at every step as if deliberately measuring the ground." Watching the bird, I am inclined to believe this high action is assumed in order not to dim the mirror of water, and thereby dull the vision of fish.

In the early days of the run I think the weka increased in numbers; now, however, the bird is getting rarer. Its cry resembles the weird moorland call of the curlew, and there are few prettier sights than a brood of lively black weka-chicks.

At long intervals, and then only for a few moments, is seen the little water-crake. Upon one occasion, however, though it is rare to see them fly, I noticed three together on the wing. Mr. Brandon describes the call, or one of the calls, of this bird as being not unlike the sound of raupo-stems crushed.

The beautiful pukeko, once a very common bird, was very nearly shot off the run while I was in England for two years. Even now that none have been killed for three years they hardly appear to increase. It seems that when once a species gets scarce it is apt to altogether disappear. Whether this is because the vermin that swarm in New Zealand have more time to spare to attend to the survivors or for some more subtle reason I do not know. The pukeko, if let alone, becomes very tame, and in spring especially loses its wildness still more. These birds are fond of grain. With their powerful beaks they used to pull the oat-straws out of our stacks. This they did with care, so as not to break the stems and thereby lose the grains at the end.

Another lake-bird is the little dabchick. As we hear the short-tailed puffin at night flying overhead, I count it also as one of our Tutira birds. It is called by the bushmen the "mutton-bird," but can be only, I think, *Puffinus brevicaudus*.

The black shag may any day be seen spreadeagling himself on some dead log, and darting his snaky neck first in one direction and then another. The white-throated shag, though rarer, is also to be found on the lake.

Of stray sea-birds we have three species on the station—or, rather, have had, for their stay is usually very brief—the common tern, the godwit (I think), and the dove-petrel. This last bird flew down to the fire beside a native hut. When offered water to drink, or even at the sound of water, this petrel would begin to shake its wings, duck its head, and go through the motions of a bird washing itself in deep water.

This last species brings the number up to thirty-five, and completes my paper on "Bird-life on a Run." I fear that I have not been able to tell you a great deal that is new, but perhaps the enumeration alone of species that have been and are on the run before or during 1895 may be of use to some future student of bird-life in New Zealand.

## Art. XXXV.—*An Ornithological Note.*

### By R. Coupland Harding.

[*Read before the Wellington Philosophical Society, 16th October, 1895.*]

In the course of searching for material for the bibliography of the moa, now being compiled by my friend Mr. A. Hamilton, of Dunedin, I read and made extracts from two works bearing the imprint of the Historical Publishing Company, Philadelphia and St. Louis. They are of the well-known class of volumes which are carried by travelling book-agents, and, I believe, have had an extensive sale in this colony. The name of J. W. Buel appears on the title-page of each as author, and the books are profusely illustrated with engravings copied from standard works. One of these volumes is entitled "Sea and Land" (1887); the other, "The Living World" (1889); and together they cover almost the entire field of natural history. The author, in his preface to "Sea and Land," says that he has made use of more than a thousand books on natural history in preparing the work.

In both these books I find references (with familiar woodcut illustrations) to the moa of New Zealand, and in each the author has curiously confounded the extinct *Dinornis* with the living *Apteryx*. He has also, in the most impartial manner, adopted the views of those who hold that the moa became extinct in prehistoric times, and of those who maintain, on the other hand, that it existed as late as our own times; and sets forth these divergent ideas without the slightest attempt to reconcile them. It is not necessary to read the whole of these passages; but one section in "Sea and Land," headed "A Bird without Wings," and illustrated with a sketch of the kiwi, gives so perfect an example, in brief compass, of the writer's method that I quote it in full:—

"A Bird Without Wings.—A single bone, found in a New Zealand watercourse, was brought to England and sent to Professor Owen. It belonged, he said, to a wingless, tailless bird, which was at least twelve feet high! Other men of science thought this to be impossible, and tried to prevent him from making his opinions known. But Professor Owen was right, and a specimen of the *Apteryx* (that is, 'wingless' bird) in due course arrived at the Zoological Gardens in London. This strange creature was nocturnal in its habits, and, if brought out into the light of day, it ran here and there in search of cover. Wingless and tailless it was, standing upon legs like those of an ostrich, and with a long bill that might

belong to a stork. This long bill had more than one use. When its ungainly owner leaned forward it was used as a support, and was also used to bore in the ground for worms, like our modern snipe. It is supposed to have become extinct during the present century, but this is hardly a justifiable supposition, since there is nothing in the traditions of the native New-Zealanders that concerns this strange creature. This fact leads to the more reasonable belief that the *Apteryx* perished off the face of the earth many centuries ago, perhaps at the time of the subsidence into the sea of that portion of the Asiatic Continent of which New Zealand was a part. The traditions of man do not extend back to this probable event."

It would be difficult to imagine anything more bewildering than the information imparted in these few lines; but it is only a specially egregious example of the blunders with which compilations of this class abound. I quote it by way of solemn warning against the showy compilations by hack writers, which are worked off in large numbers on a confiding public by the agents commonly known as "book-fiends."

## ART. XXXVI.—*Notes on Rare Lepidoptera in Wellington.*

By WALTER P. COHEN.

[*Read before the Wellington Philosophical Society, 17th July, 1895.*]

I HAVE much pleasure in reporting the following Lepidoptera as plentiful in Wellington during last season:—

### RHOPALOCERA (Butterflies).

Nothing very startling was taken last season, not having even seen a solitary *Vanessa itea*.

*Porina enysii.*

One specimen, which flew into a town shop-window, attracted by the light, during the month of January, and which was presented to me.

### NOCTUINA.

*Mamestra stipata.*

One specimen only, which was taken in December.

*Mamestra prionistis.*

One specimen only, which was taken in December.

### Geometrina.

*Gonophylla nelsonaria.*

One specimen only last season, taken in Botanical Gardens during February. Generally appears this month for a short period only. I took none the season before. I have now twelve specimens.

### Tortricina.

*Nymphostola galactina.*

This pretty and once-rare little insect, which has already been amply described by Meyrick (vol. xvi. of the Transactions), I found very plentiful in the Wellington Botanical Gardens only. It appears on the wing at dusk where the swamps exist. The food-plant I am uncertain of, though Professor Hutton bred his from a green pupa on *Myrtus bullata;* but all my moths I found settling on the leaves of *Pittosporum tenuifolium* and *Griselinia lucida*, which they had flown up to from the swamps below. It is taken from early in December till February, but this past season I saw none after January had gone by, as some of the nights were cold. On 16th December—a very mild night—I took sixteen, and could have gone on securing nothing else, though on an average I seldom saw more than two about in one evening. I have obtained thirty in three seasons. The wing-measurement varies from 14 to 18 lines across from tip to tip. The dark-grey spot which is mentioned by Meyrick, and found in the disc of the middle of the upper wing, is hardly visible in some of my specimens, appearing as if only spotted with faint minute dots at intervals; otherwise I have no other varieties in this species.

*Heterocrossa eriphylla.*

Five specimens last season, taken near last locality. It seems very fond of settling on the trunks of weeping-willows in the daytime. I have never taken it at night. I have twenty specimens, all taken during the day from December to April.

*Epalxiphora axenana.*

Five specimens last season, locality of Wellington, found on broom and other plants. Varies very much in markings on wings; flies at night-time, from October to March. Twelve specimens taken.

### Tineina.

*Semiocosma epiphanes.*

Four specimens last season, found throughout the district. It is fond of sitting on palings and tree-trunks, appearing from October to February, in the daytime, when I took mine, which now number thirteen.

*S. peroneanella.*

Four specimens last season, widely distributed in district, being sometimes found in the heart of the city—at night-time only—from about November to March. I have nine specimens.

*S. picarella.*

Two specimens last season; one taken outside a town shop-window, attracted by the gaslight. I have only taken it in November and December, and now possess three.

## ART. XXXVII.—*On the Unusual Abundance of Certain Species of Plume-moths during the Summer of 1894–95.*

By G. V. HUDSON, F.E.S.

[*Read before the Wellington Philosophical Society, 21st August, 1895.*]

THE laws governing the relative abundance of different species of animals and plants are so obscure, and at present so little understood, that it is always desirable to record the appearance of any species when it occurs in unusual numbers.

Last summer I noticed that the three species of forest-dwelling plume-moths (*Pterophorus monospilalis*, *P. lycosema*, and *P. furcatalis*) were phenomenally common here. *Pterophorus monospilalis*, a pure-white species, one of the most delicately beautiful insects we have in New Zealand, was to be found in the utmost profusion, as many as three or four specimens being disturbed from amongst the ferns and dense undergrowth at once. *Pterophorus lycosema*, distinguished by having a broad band of brown on the fore-wing reaching as far as the end of the posterior digit, was also extremely abundant, though not quite so common as *P. monospilalis*. *P. furcatalis*, distinguished by having a broad band and both digits of the fore-wings brown, was commoner than usual, but much scarcer than either of the two preceding species.

I have much pleasure in exhibiting series of all three species before the Society this evening, and have mounted them on a dark background in order that their extremely elegant appearance may be seen to advantage. I ought perhaps to explain that, as a rule, these three insects are not very common—that is to say, one would not expect to meet with more than one or two specimens during a day's collecting in a favourable locality.

## Art. XXXVIII.—*Further Coccid Notes: with Descriptions of New Species, and Discussion of Questions of Interest.*

By W. M. Maskell, Registrar of the University of New Zealand, Corr. Mem. Roy. Soc. of South Australia.

[*Read before the Wellington Philosophical Society, 18th December, 1895, and 26th February, 1896.*]

Plates XVI.-XXIII.

### The Larvæ of Coccidæ.

In order to gain a thorough knowledge of any family of insects it is desirable that the life-history of the species composing it should be studied as carefully as possible. As regards the habits of the insects, their manners and customs, or their influence upon plants or upon other animals, it is undoubtedly difficult for any one who does not live in their own country to properly investigate these points; and an observer who receives specimens from other lands than his own can scarcely be able to study them completely from this point of view. But at least it is desirable that when a new species is erected, or new observations are made upon known species, the insects under review should be examined as much as possible in all stages of life and in both sexes. In the case of *Coccidæ*, the males are unfortunately by no means generally available, especially when specimens are received for identification from a distance; for collectors are seldom careful to capture with the specimens attached to plants the small winged flies which they may see hovering about the females. Many instances, however, have occurred in my experience of males arriving in my hands either hatched out in transit or else in the pupa stage ready to emerge; and in this way I have been able to describe the males of many species. Larvæ, on the other hand, almost always accompany the adults; either they exist alongside of them on the leaves or they hatch out, sometimes in considerable numbers, even after the specimens have been a long time in the boxes. With the exception of the *Diaspidinæ*, where the specific differences in the larvæ are usually very slight (and in some cases even in that group), I have been careful to describe the larvæ of any new species erected by me, and also the second female stage and the male pupa whenever possible: for a mere hasty description of an adult, with perhaps very insignificant differences from other species, without any attempt to discuss other states which might throw much light on the relationships, seems quite inadequate for scientific purposes. Even in cases where there is no know-

ledge of the earlier states available I think the fact should be mentioned; and for this reason I have nearly always (except in the *Diaspidinæ*) inserted the words "Larva unknown" or "Second stage unknown."

It has occurred to me that a type-series of figures may not be useless as a guide to the study of Coccid larvæ, and two plates containing such figures are therefore attached to this paper, showing the abdominal extremities, the antennæ, and the feet of the eight principal sections into which the family is divided (Plates XVI., XVII.). I have purposely drawn these figures so as to include as far as possible the most important characters, without special regard to any particular species or even genus, though the variations in the four last groups have necessitated a double arrangement of the abdominal extremities. It will be seen, however, that in these double figures the differences shown are by no means fundamental: thus, for example, in the *Monophlebus* section of the *Monophlebinæ* the difference from *Icerya* is merely in the number of the setæ, the principal character being identical in both—namely, the springing of the setæ from the last segment without any tubercles or lobes. As regards the feet, the general similarity in all the groups is apparent; and the point is to be noted that in every case the tibia is shorter than the tarsus. Morphologically, the antennæ also are similar throughout, having always six joints, the aberrant antenna of *Tachardia melaleucæ* really emphasizing the rule. I have given a figure of this antenna (Plate XVII., fig. 4*d*), partly on this account and partly to show its approach to the type-form of the *Diaspidinæ*.

Lest, however, I should be thought to mean that any of the types here shown is to be taken as so definitely fixed as to be rigid, I venture to repeat a passage in my paper of 1890 (Trans. N.Z. Inst., vol. xxiii., p. 32): "Whatever may be the rule amongst other orders and families of insects, Coccids present this difficulty to students: that one must be prepared at any time to find very distinct departures from generic, or even group, types, and to consider any character whatsoever as elastic and variable." *Tachardia melaleucæ* will again furnish an example of this, as the abdominal extremity of the larva is as aberrant as its antenna.

Note here, with regard to the foot, that in the *Monophlebinæ* there is only one digitule on the claw. Note also that the appearance shown in Plate XVI., fig. 2*b*, where slight pressure has caused the anal ring to protrude some distance from the terminal cleft, is not infrequent in mounted specimens of Lecanid larvæ, although by no means constant. Signoret, in his "Essai," gives a similar figure in *Philippia oleæ*, a Lecanid. Note, finally, that in my Plates I have

omitted to show any marginal spines except on the anal tubercles, as these are in most cases only specific characters.

*Synopsis of Larval Characters.*

Abdomen terminated by two or more minute subcylindrical lobes as in the adults; setæ not springing direct from the lobes; antennæ of six irregular joints; feet with tibia shorter than tarsus; digitules four *Diaspidinæ.*

Abdomen distinctly cleft posteriorly; above the cleft two dorsal lobes not extending beyond the margin; lobes setiferous; antennæ of six regular joints; feet with tibia shorter than tarsus; digitules four ... *Lecaninæ.*

Abdomen terminated by two conspicuous protruding tubercles; tubercles spiniferous and setiferous; antennæ of six regular joints; feet with tibia shorter than tarsus; digitules four ... ... ... *Hemicoccinæ.*

Abdomen terminated by two conspicuous protruding tubercles; tubercles spiniferous and setiferous; antennæ of six regular subequal joints; feet with tibia shorter than tarsus; digitules four ... ... *Acanthococcinæ.*

Abdomen terminated by two very inconspicuous tubercles, scarcely protruding; tubercles spiniferous and setiferous; antennæ of six regular joints, the last the longest; feet with tibia shorter than tarsus; digitules four ... ... ... *Dactylopinæ.*

Abdomen terminated by two tubercles, conspicuous and protruding or small and not protruding; tubercles spiniferous and setiferous; antennæ of six regular subequal joints; feet with tibia shorter than tarsus; digitules four ... ... ... *Idiococcinæ.*

Abdomen not terminated by any lobes or tubercles; setæ springing direct from margin; antennæ of six regular joints, the last the longest; feet with tibia shorter than tarsus; digitule one ... *Monophlebinæ.*

Abdomen terminated by small tubercles, slightly protruding; tubercles setiferous; antennæ of six regular subequal joints; feet with tibia shorter than tarsus; digitules two ... ... ... *Brachyscelinæ.*

## Genus ASPIDIOTUS.

**Aspidiotus hakeæ**, sp. nov. Plate XVIII., figs. 1–6.

Puparium of female circular, slightly convex; colour greyish-white; pellicles dark-orange, central; diameter about $\frac{1}{16}$in., but rather variable. The median portion is frequently rubbed off, leaving the pellicles exposed, with a ring of secretion.

Puparium of male circular, smaller and whiter than that of the female; diameter about $\frac{1}{30}$in.

Adult female orange-yellow; form normal of the genus, the thoracic segments overlapping the abdomen. Length about $\frac{1}{50}$in. The abdomen is rather short and truncate; the margin is very minutely serratulate, but there are no terminal lobes, though in some specimens a small median club-shaped organ is visible within the margin. There are no groups of spinnerets, but a single row of separate circular orifices runs along the margin, and a few others are scattered over the body. The epidermis is very minutely striated, and thus presents a kind of velvety appearance.

Female of the second stage (the second pellicle) sub-elliptical, tapering posteriorly. The abdomen ends in two conspicuous median lobes, which are narrow, with straight parallel sides and emarginate ends; at each side, separated by a deepish depression, is a smaller lobe, bidentate and sloping towards the median lobes; at a short distance along the margin is another depression, and the whole margin is broken by serrations.

The first pellicle (the latest stage of the larva) is sub-elliptical, tapering posteriorly, and the abdomen terminates almost as in the second stage. But in this stage the exuviæ of the antennæ and feet are clearly visible; moreover, close alongside the rostrum are two groups of spinneret-tubes, each group containing about thirty-five; these tubes end in circular simple orifices.

The larva (early stage) is dark-orange or red, elliptical, active; length about $\frac{1}{100}$in. Antennæ and feet presenting no special features. The abdomen ends in two median conspicuous lobes, cylindrical and converging, the outer sides emarginate; between the lobes are two longish setæ. Close to the rostrum are the two groups of spinnerets as in the first pellicle.

The second stage, or pupa, of the male is dark-orange or red, elliptical; length about $\frac{1}{50}$in. The abdomen has a minutely serratulate and thickened margin, but there are no lobes; the extremity is somewhat truncate. On each abdominal segment is a transverse row of large oval spinneret-orifices, which are on both the dorsal and the ventral surfaces.

Adult male dark-red; length, exclusive of the spike, about $\frac{1}{50}$in.; the spike is about as long as the abdomen. Antennæ, feet, &c., presenting no special characters.

*Hab.* In Australia, on *Hakea* sp. My specimens were sent by Mr. Olliff, from Sydney.

This species may be recognised by the entire absence of abdominal lobes in the adult female, and their presence, conspicuously, in the pellicles; also by the groups of rostral spinnerets in the first pellicle and the large oval ones in the male pupa. In *Aspidiotus acaciæ*, Morgan, similar groups are seen near the rostrum, but in the adult state; and although the adult female of that species has very small and (apparently) not protruding lobes, yet these are present. I believe that *A. hakeæ* is clearly distinct.

**Aspidiotus virescens**, sp. nov. Plate XVIII., figs. 7–10.

Puparium of female subcircular, flat, greyish-white; diameter about $\frac{1}{16}$in. Pellicles subcentral; the larval pellicle is distinctly green, the second pellicle greenish in the middle and yellowish on the borders. The texture of the secreted portion of the puparium is thin and papery.

Puparium of the male subcircular, snowy-white, flat; the single pellicle subcentral, green. Diameter about $\frac{1}{30}$in.; the texture very thin, delicate, and papery.

Adult female of the usual peg-top form; colour yellow, with a greenish tinge. Length about $\frac{1}{30}$in. Abdomen ending in six subequal lobes, not set closely together; each lobe is narrow at the base, widened in the middle, and narrowed again towards the end; between the lobes, and extending along almost the whole abdominal margin, are very numerous broad scaly hairs, the ends of which are deeply serrated. There are four groups of spinnerets; upper groups with 17–21 orifices, lower groups with 8–13. Dorsally, there are great numbers of tubular spinnerets.

Adult male yellow, with a greenish tinge; length about $\frac{1}{40}$in., exclusive of the spike, which is about half as long as the body. The organs present no distinctive feature.

*Hab.* In Australia, on *Eugenia smithii.* My specimens were sent by Mr. Froggatt; locality not named, but probably near Sydney.

This species may be distinguished by the terminal lobes and scaly hairs, as well as by the papery, thin puparia, and the distinctly green pellicles.

**Aspidiotus ficûs** (Riley), Comstock. Rep. Entom. U.S. Dept. Agric., 1880, p. 296.

Occurs in India, on orange, at Khandallah. My specimens were sent by Dr. Alcock, Superintendent of the Indian Museum, Calcutta.

**Aspidiotus cladii,** Maskell, 1890.

I have lately received from Mr. A. Cooper, of Richmond, Natal, some pieces of aloe having on them several specimens of an *Aspidiotus* which is very clearly *A. cladii*. I have never before seen this insect from any place outside Australia, in which country it seems to be widely spread, as I have had specimens from nearly every portion of the continent. The species must have been taken to South Africa (I suppose) in some ship, perhaps on decorative plants for the saloon, or in a Wardian case. Mr. Cooper tells me that the aloe in question seems to be not seriously damaged; and I have not heard that *A. cladii* is injurious in Australia, although common enough. But this is a good instance of the way in which nowadays Coccids are being spread about the world; and, more than this, it is another nail in the coffin of that old fancy that Coccids may be recognised to some extent by their food-plants. Very probably *A. cladii* will be found ere long in other countries and upon all sorts of plants. Few people, I take it, will care in future to erect new species simply from finding insects on plants not hitherto known to have been attacked by them.

**Aspidiotus eucalypti,** Mask., var. **comatus,** var. nov. Plate XVIII., fig. 11.

Puparium of female circular, greyish-white, slightly convex; as in the type.

Puparium of male narrow, subelliptical, white, not carinated; as in the type.

Adult female of the general form, colour, and size of the type, with a similar characteristic deep groove. The abdomen ends in two conspicuous lobes, but these are not laterally incised, and there is also at each side a small, sharply-triangular lobe. The margin bears on each side ten rather long slender hairs, which are arranged in pairs, not singly as in the type. There are no groups of spinnerets.

*Hab.* In Australia, on *Eucalyptus viminalis*. Specimens from Melbourne, sent by Mr. French.

The non-incised lobes and the longer hairs in couples will distinguish this variety.

I find that in my original description of *A. eucalypti* I omitted to mention that the puparia (and the same holds good for the variety) are covered, when uninjured, by a very thin scale formed of the minute bark-cells of the tree. In this state the pellicles are very inconspicuous, and the whole has a grey appearance. Frequently, however, this scale is rubbed off, and then the pellicles are much more clearly visible, surrounded by a ring of whitish secretion.

*A. articulatus*, Morgan, 1889, comes near to *A. eucalypti*

in its characteristic groove, but its abdominal characters differ very clearly.

**Aspidiotus perniciosus,** Comstock; and a variety. Rep. Entom. U.S. Dept. Agric., 1880, p. 304.

This insect occurs in Australia on apples and pears. I have received specimens from Melbourne sent by Mr. French, and from New South Wales sent by Mr. Benson. It was reported in that country first by Mr. Olliff, in the Agricultural Gazette of New South Wales, 1892, p. 698.

In a paper forwarded to the *Entomologists' Monthly Magazine* I have discussed the relationships or differences between this species and *Aonidia fusca*, Mask., 1894.

In August, 1895, I received from Mr. Quinn, of Adelaide, some twigs of *Eucalyptus corynocalyx* thickly covered with insects which, after careful examination, I must attach to *A. perniciosus*. The puparia in this instance are very dark grey, and the larval pellicle is orange-red. The second pellicle is not visible until the scale is turned over, and then only indistinctly. But the characters of the adult female are quite clearly those of *A. perniciosus*, and in this case I have also the advantage of finding some adult males, which are identical with the figure of *A. perniciosus* given in "Insect Life," vol. vi., p. 369. Mr. Quinn says nothing about the presence of the insects on any European fruit-trees; but as to the *Eucalyptus* he remarks, "seems to destroy the bottom branches of young trees where it has been for a year or two."

It appears to me clear that *A. perniciosus* may vary a good deal in the colours of its puparia and of their pellicles. I have therefore placed this insect in my cabinet with the label "*A. perniciosus* var."; but I will not add the word "eucalypti," as I have no reason to think that it is peculiar to that family of trees.

### Genus Parlatoria.

**Parlatoria myrtûs,** Maskell. Trans. N.Z. Inst., 1890, p. 12.

I have received specimens of this insect from Adelaide, South Australia, on *Laurustinus*. They were sent by Mr. Quinn, who says, "fairly common on that plant, though its injurious effects are not very apparent."

**Parlatoria zizyphi,** Lucas. Lucas, Ann. de la Soc. Ent. de France, 1853; Signoret, Essai sur les Cochenilles, p. 132.

This insect has been sent to me by Mr. Lea, on lemons from Perth, Western Australia; the fruit was imported there

"from Sicily." It has never before been reported, as far as I know, from any place south of the Line, nor indeed from outside Europe and Algeria, except that Comstock (Rep. 1883) says it is sometimes found in the United States on oranges in the markets.

## Genus MYTILASPIS.

**Mytilaspis acaciæ**, sp. nov. Plate XIX., figs. 1, 2.

Female puparium mussel-shaped, slightly convex, and usually curved; colour dull dark-greyish-brown, scarcely lighter than the bark of the tree; length about $\frac{1}{16}$in. Larval pellicle small, yellow, terminal; second pellicle very inconspicuous, reaching about one-fourth the length of the puparium.

Male puparium mussel-shaped, not carinated; colour of the secreted portion greyish-brown, lighter than that of the female; length about $\frac{1}{25}$in. Pellicle terminal, small, orange-red in colour.

In all the specimens seen the female puparia were massed in great numbers on twigs, quite separate from the equally-numerous male puparia; and these latter, from their orange-red pellicles, presented altogether a more ruddy appearance than the former.

Adult female dark-brown, elongated, the general form normal of the genus; length about $\frac{1}{20}$in. Abdomen ending in four lobes, of which the two median are the largest, and are rather wider than long, with the outer edges crenulated; between these and the two smaller lobes are small marginal depressions, with minute spines; the small lobes are cylindrical, with rounded emarginate outer edges; beyond them the margin of the abdomen is broken by many conical serrations bearing spines. There are no groups of spinnerets, but some oval large pores.

Adult male red; form normal, presenting no special features; length of body about $\frac{1}{25}$in. The anal spike is as long as the abdomen.

*Hab.* In Australia, on *Acacia linifolia*. My specimens were sent by Mr. Froggatt, from Hornsby, near Sydney.

This is the species of which I remarked in my paper of 1894, under *Aspidiotus extensus*, that I possessed a number of male puparia but could not determine them in the absence of the females. Having received these I have no doubt of the genus of the insect, and from the absence of spinneret-groups, and from the characters of the abdominal margin, I do not hesitate to consider it as distinct. The separation of the males from the females is, as I remarked in 1894, a not very rare occurrence amongst Coccids.

**Mytilaspis pallens**, Maskell, 1889, var. **alba**, var. nov.

Puparium of female snowy-white, elongated, narrow; length about $\frac{1}{8}$in. Pellicles terminal, pale-yellow.

Puparium of male similar to that of female, but smaller; not carinated; length about $\frac{1}{20}$in.

Adult female as in the type.

Adult male not observed.

*Hab.* In Australia, on *Xanthorrhœa* sp. My specimens were sent by Mr. Froggatt, from Sydney.

I see nothing but the whiteness and the slightly larger size of the puparia to separate this from the type.

In my original description I mentioned as the food-plant of this species "a kind of fan-palm." I now find that the pieces sent were *Xanthorrhœa:* their triangular form misled me.

**Mytilaspis banksiæ**, sp. nov. Plate XIX., figs. 3–5.

Puparium of female dull-rusty-buff-coloured (similar to the underside of the leaf); convex, broadly pyriform and short; pellicles dull-red, usually covered by a thin scale of rusty secretion, which, however, is frequently rubbed off. Length of puparium about $\frac{1}{27}$in. Many puparia are almost sub-elliptical.

Puparium of male similar in colour to that of the female, but much narrower and more cylindrical; not carinated; length about $\frac{1}{27}$in.

Adult female dark-red, the median dorsal region sometimes yellow. Form normal of the genus, but frequently so much shortened as to be almost globular; the proper length is about $\frac{1}{35}$in. Abdomen ending in six lobes, of which the two median are the largest, the outer ones the smallest. The median lobes are not quite adjacent; their sides are straight, the ends obliquely emarginate. The second pair are deeply incised on the outer edges; the third pair are bidenticulate. Between the lobes the margin has deep semicircular depressions with thickened edges, and beyond the lobes the margin is broken by many serrations. There are a few short scaly hairs between the lobes, and on the marginal serrations there are many others larger and longer; all these hairs have deeply-serrated ends. Five groups of spinnerets: upper group with 8–10 orifices; upper laterals 20–22, lower laterals 20–22. There are a great many dorsal spinnerets on all the segments as high as the rostrum, and on the anterior cephalic region are some short fine hairs.

Adult male dark-red; length (exclusive of the spike) about $\frac{1}{75}$in.; the spike is about half as long as the body. The feet, antennæ, &c., present no special features.

*Hab.* In Australia, on *Banksia integrifolia.* My specimens

are from Mr. French, who collected them near Melbourne, "within full reach of the sea-spray."

I was long in doubt, considering the very short puparia and the almost globular form of some amongst the specimens sent to me, and also the numerous serrated scaly hairs on the abdominal margin, whether this insect ought not to be placed in the genus *Parlatoria*. But after careful examination I have concluded that the pellicles are always quite terminal, and the puparia really pyriform; and that the female is really elongate and not globular. Moreover, no species of *Parlatoria* has more than four groups of spinnerets. On the whole, therefore, I place the insects in *Mytilaspis*, having regard to the non-carinated male puparium.

This species may be considered as at least semi-aquatic, for Mr. French tells me the plants on which it was found are quite constantly wetted by the sea-spray.

**Mytilaspis melaleucæ**, sp. nov. Plate XIX., fig. 6.

Puparium of female elongated, pyriform, convex; colour of secreted portion greyish-white; pellicles terminal, dark-orange. Length of puparium about $\frac{1}{16}$in.

Puparium of male elongated, subcylindrical, convex, not carinated; secretion white; pellicle terminal, orange. Length about $\frac{1}{25}$in.

Adult female yellow, elongated. Abdomen ending with four very small lobes, not close together; the two median lobes are a little larger than the others and are cylindrical, with the ends rounded but emarginate; the outer lobes are conical. Margin of the abdomen broken by many small serrations, and bearing several short hairs, of which there are two between each pair of lobes. Five groups of spinnerets: upper group with 3 orifices; upper laterals 6–8; lower laterals 4–6. Several dorsal tubular spinnerets along the margin.

Adult male unknown.

*Hab.* In Australia, on *Melaleuca* sp. My specimens were sent by Mr. Froggatt, from Ballina, Richmond River, New South Wales.

The puparia of this species approach *M. casuarinæ*, *M. spinifera*, &c.; and also to *Poliaspis exocarpi*; but the abdominal characters differ from any hitherto described.

## Genus CHIONASPIS.

**Chionaspis prunicola**, Maskell, var. **theæ**, var. nov. Plate XIX., figs. 7–8.

I have received from the Indian Museum, Calcutta, some specimens which, after very careful examination, I must attach to *C. prunicola*. The female puparium is a little more elongated, and the anterior abdominal margin has fewer

spines; but in the terminal lobes and serrations the insect is identical with the type. The groups of spinnerets have usually more numerous orifices, the lower laterals having 36–42; but this is a very variable character in most Diaspids. Curiously, in three specimens examined the right upper lateral group was entirely absent, or was represented by only a single orifice.

*Hab.* In Northern India, on tea; no special locality was mentioned. If, as is quite possible, the tea-plants in question should have been imported from Japan, the relationships of this variety may be easily accounted for.

I have only lately been informed that Professor Sasaki, of Tokyo, has described my *C. prunicola* under the name of *Diaspis patelliformis*. In my original description (Trans. N.Z. Inst., vol. xxvii., p. 49) I mentioned how nearly the puparium approached that of a *Diaspis*, but gave reasons for not considering the species as of that genus. I have not yet had an opportunity of seeing Professor Sasaki's paper, nor do I know whether it has priority over mine or not. But I am obliged to adhere to my opinion for the present, and leave both the species and the variety in *Chionaspis*.

**Chionaspis spartinæ**, Comstock, var. **natalensis**, var. nov. Plate XIX., figs 9–11.

Puparium of female white, very elongated, narrow, subcylindrical; length about $\frac{1}{12}$in.; width about $\frac{1}{50}$in. Pellicles terminal, small, yellow.

Puparium of male white, elongated, cylindrical, carinated; length about $\frac{1}{30}$in.

Adult female pale-yellow; form normal of the genus. Abdomen ending in four very small lobes, of which the two median are the largest; the two others are almost obsolete. The median lobes are roundly triangular, divergent; the outer pair are denticulate. The margin is broken by small serrations, and bears a few spiny hairs, of which two on each side are close to the median lobes. There are five groups of spinnerets: upper group with 10 orifices; upper laterals 20–24; lower laterals 16–20. Many large oval pores.

The larva is small, elliptical, active; length about $\frac{1}{100}$in. The general characters are normal, but the last joint of the antenna is rather thicker and more clavate than usual amongst the *Diaspidinæ*.

Adult male unknown.

*Hab.* In Natal, on grass. My specimens were sent by Mr. A. M. Cooper, from Richmond, Natal.

This insect is very close to *C. spartinæ*, and I think the chief difference is in the numbers of the spinneret-orifices, which are fewer in var. *natalensis* than in the type. Com-

stock's species was found on "salt-marsh grass" much exposed to sea-spray. Mr. Cooper merely says "on grass," but does not mention the species.

Genus POLIASPIS.

**Poliaspis exocarpi,** Maskell.

This species appears to be by no means uncommon in Australia. I have had specimens during the year from various parts of New South Wales, on *Dillwynia ericifolia* and other plants.

There is one feature of this insect which is noticeable. I find that in all my mounted slides it is very difficult to detect the spinneret-groups. As a rule these are as clear (or nearly so) in all Diaspids when finally mounted in dammar or balsam as when examined in alcohol or water; but, of the four slides of *P. exocarpi* in my collection, there is only one which shows with any clearness at all the double sets of groups, and that by no means as clearly as could be wished. Specimens which, in alcohol, show the groups with perfect distinctness are almost useless for identification after the mount is completed.

Genus FIORINIA.

**Fiorinia expansa,** Maskell.

I have received many specimens of this handsome species from Mr. C. T. Musson, of Hawkesbury, New South Wales, on *Melaleuca linariifolia*. These are much larger than the original type, the puparia reaching $\frac{1}{16}$in., but in other respects agree completely.

Section LECANINÆ.

Genus LECANIUM.

**Lecanium scrobiculatum,** Maskell. N.Z. Trans., vol. xxv., 1892, p. 221.; vol. xxvii., 1894, p. 58.

I find that this is a somewhat variable species, which is apparently not uncommon in New South Wales, principally on *Acacia*. Having received, since my paper of 1894 was printed, some specimens of the larvæ, I am enabled now to say that they do not differ from those of the form which in that paper I named *L. pingue*. Further, having had also another supply of *L. pingue*, I find that the feet are not really absent from that form, but are nearly atrophied, very small and somewhat swollen. Still further, Mr. Froggatt has sent me several specimens of an insect so closely resembling, in its anatomical characters, both of the above forms, although differing slightly in colour and in having no dorsal tubercles, that I am obliged to consider it as another variety.

For the foregoing reasons I have to abandon *L. pingue* as a distinct form and to classify the species anew as follows, regarding its general features:—

*L. scrobiculatum*, type.—Adult female convex, colour brownish-yellow or reddish-brown; epidermis bearing very numerous pits; feet not abnormally short; dorsum with four to six circular tubercles.

*L. scrobiculatum*, var. *pingue*.—Adult female convex, colour reddish-brown; epidermis bearing very numerous pits; feet atrophied; dorsum with four to six circular tubercles.

*L. scrobiculatum*, var. *leve*, var. nov.—Adult female convex, colour usually dull-yellow or brownish-yellow, with dull-red patches; epidermis bearing many pits (but less numerous than in the type); feet atrophied; dorsum without any circular tubercles.

The second stage of the female, the larva, and the test of the male pupa do not seem to vary sufficiently in these forms to require separate description. The first and third are described in my paper of 1892, and the larva in my paper of 1894 under *L. pingue*.

My specimens of var. *leve* were sent by Mr. Froggatt on *Acacia longifolia*, from Manly, near Sydney.

**Lecanium mori**, Signoret.

I have to report this species as plentiful on gorse (*Ulex europæus*) and broom (*Spartium* or *Genista*) at Fairlie, South Canterbury, New Zealand. My specimens were sent by Mr. T. Kirk.

I mentioned *L. mori* first in 1884 as occurring in New Zealand on *Alsophila*; and in 1893 here also on *Asplenium* and other ferns. The gorse and broom on which I now record it are, of course, European, and, if my recollection serves me correctly, there is not much, if any, native forest near Fairlie. The anatomical characters of the insects, as I observed in 1893, correspond most exactly with those of Signoret's species. The question arises as to the original country of *L. mori*. Signoret's specimens were found upon mulberry (presumably) in the south of France. That author does not himself mention the plant, and it is within possibility that "*mori*" is not meant to indicate the mulberry; but, however that may be, I have not found the species mentioned by any other writer as occurring in Europe or elsewhere. Neither Mr. Douglas nor Mr. Newstead reports it in England, although both have paid much attention to the genus *Lecanium*. Possibly, however, the species named *L. assimile*, Newst. (Ent. Mo. Mag., May, 1892, p. 141), may be the same or a variety. *L. genistæ*,

Sign., and *L. sarothamni*, Newst., differ sufficiently from it. The ferns on which *L. mori* occurs in New Zealand are indigenous species, and, in the case of *Alsophila* and *Nephrolepis*, are also of indigenous genera; and it is of course possible that some New Zealand ferns imported into the south of France and the Riviera may have taken their *Lecanium* with them.

## Genus PULVINARIA.

**Pulvinaria thompsoni**, sp. nov. Plate XX., figs. 1–8.

Adult female at first yellowish-brown, darkening with age to red-brown or brown; frequently massed together on a twig, the cotton confused and heaped up, but on a leaf usually separate, with a posterior cylindrical white ovisac. The insect shrivels considerably at gestation, but in the early state reaches about $\frac{1}{8}$in. The form is Lecanid, elliptical, flattish. Antennæ of eight joints, of which the third is twice as long as any other, the second and first next and subequal, the rest much shorter and about equal to each other; the eighth joint is irregularly tapering, and bears several hairs. Feet moderately large; the tarsal digitules are fine hairs, the digitules of the claw very large and widely dilated. Epidermis bearing a few circular spinnerets and also a few scattered short fine hairs; and on the margin is a row of similar fine hairs set rather closely together. Each of the marginal depressions bears three, or sometimes four, strong club-shaped spines. Abdominal cleft, lobes, and anal ring normal.

Female of the second stage yellowish or light-brown, elliptical, flattish; length about $\frac{1}{18}$in.

Test of male pupa white, glassy and transparent, angular-elliptical, with sloping sides and the top formed of a flat plate; length about $\frac{1}{18}$in.

Larva dull-red, flattish, elliptical; length about $\frac{1}{40}$in. Antennæ of six joints. Abdominal setæ moderate.

*Hab.* In Tasmania, on *Dodonæa viscosa*. My specimens were sent by the Rev. Mr. Thompson, of Hobart.

This species differs from *P. dodonææ*, Mask., 1892, in the eight-jointed antennæ, in the larger digitules of the claw, in the very small number of dermal spinnerets, in the spines of the marginal depressions, in size, and in colour.

**Pulvinaria tecta**, Maskell.

Specimens of this have been sent by Mr. C. T. Musson, from Richmond, New South Wales; they are of the white, or New South Wales, variety, the Victorian specimens having yellowish cotton. These specimens are on *Daviesia ulicina*.

## Section HEMICOCCINÆ.

### Plate XX., figs. 9–17.

In 1883 I proposed (Trans. N.Z. Inst., vol. xvi., pp. 125–128) a classification of the Lecanid and partly Lecanid genera of the Coccid family, which seemed to me to possess at least the merits of clearness and simplicity. I followed this classification in my "Scale Insects of New Zealand," 1887, and I have since seen no reason for departing from it. According to this system I separated from the Lecanids proper, without for that reason attaching them to the Coccids proper, certain genera in which the larvæ present distinct and conspicuous anal tubercles, while the later female stages have the abdomen cleft and two dorsal lobes not reaching the margin. I proposed to attach all such species as were naked to a subsection "*Kermitidæ,*" and all such as were covered with wax to a subsection "*Cryptokermitidæ.*"

During the past year I have received from Mr. Froggatt some specimens of a species which appears to belong to the *Cryptokermitidæ,* having a conspicuous test of waxy secretion. Unfortunately, I have only larvæ and females of the second stage, and therefore I am unable to name the species, or even to decide upon the genus in which it should be placed. But the characters of the two stages which I possess are so clear that I shall probably not err in at least attaching them to the Cryptokermitids; the larvæ have anal tubercles, and the second stage has the abdomen cleft, so that in all probability the adult will be cleft also.

The female of the second stage is orange-coloured, flat beneath and convex above, elliptical; length about $\frac{1}{12}$in. The dorsum is raised in the middle in a longitudinal ridge of irregular tubercles or humps, and is covered with a test of white or yellowish wax, which is not homogeneous but broken up into irregular granular masses. At the margin (especially on the abdomen) this test is produced in spiny projections, and frequently also the dorsum has waxy spines. After treatment with potash the form is elliptical with a slightly wavy outline. Antennæ of seven short joints, subequal except the third, which is rather the longest; the last bears some hairs, of which one is rather long. Feet short and rather thick; the tibia and tarsus are about equal; digitules fine hairs. The dorsum bears many very small circular spinnerets. The margin has a row of short conical spines set rather closely together, and the four which are opposite the thoracic spiracles are very long and slender. The abdomen is distinctly cleft, and has the normal lobes of *Lecanidæ*; the anal ring has six long strong hairs, and after pressure frequently protrudes beyond the abdominal margin.

Larva orange-yellow, elliptical, slightly convex; length about $\frac{1}{60}$in. Dorsum sparsely covered with similar wax to that of the second stage. Antennæ of six rather confused short joints, of which the last bears some hairs. Feet moderate; the tarsus is almost, or quite, as long as the tibia. The margin of the body has the row of conical spines, and the four longer ones, as in the second stage. The abdomen ends in two conspicuous and prominent anal tubercles, each of which bears a few fine spines and is terminated by a long seta.

*Hab.* In Australia, on *Banksia serrata.* My specimens were sent by Mr. Froggatt from Manly, near Sydney. I have asked him to procure, if possible, some adults, in the absence of which I can decide neither the genus nor the species, though there seems every probability that it will be a *Kermes.*

## Group COCCINÆ.

### Genus PROSOPOPHORA.

**Prosopophora atherospermæ,** sp. nov. Plate XXI., figs. 1–8.

Adult female covered by a rather thick waxy test, which is of a nearly brick-red colour, slightly elliptical and convex; length about $\frac{1}{10}$in. There is a median longitudinal raised ridge of small tubercular swellings, each corresponding to a segment of the insect; on each side of this are two other similar but smaller longitudinal ridges; and, the shallow depressions in all the ridges being continuous, the test has the appearance of being transversely, and somewhat conspicuously, corrugated and barred. The apex of each small tubercle is lighter-coloured than the rest. Sometimes, however, the whole test is almost or quite white: this may possibly be due to incipient parasitism, although I can find no difference in the enclosed females. The ventral surface of the test is a flat plate of wax, with a perforation for the insect's rostrum. At the posterior extremity, dorsally, there is a small orifice, with somewhat protruded and raised edges. There is no marginal fringe; but in some specimens a small quantity of white cotton may be seen beneath the edge of the test.

Test of male pupa waxy, darkish-yellow, cylindrical; length about $\frac{1}{20}$in. Dorsally it has rows of small tubercles like those of the female, but these are proportionately smaller in comparison with the depressions, so that the test is more conspicuously corrugated transversely, with the exception of the posterior region, which is a flat sloping plate, hinged for egress of the male.

Adult female dark-red; filling the test, but shrivelling at gestation. Form slightly elliptical, convex dorsally. An-

tennæ of eight subequal joints; the third is sometimes rather longer than the others; on the last joint are several hairs, and there is one on the seventh. Feet entirely absent. Rostrum moderate; mentum monomerous. Abdomen ending with two divergent, rather large, anal tubercles, each bearing a shortish seta but no spines; close alongside each tubercle is a longer seta; each tubercle has its dorsal surface striated with a reticular pattern. The margin of the body has two small depressions at each side opposite the thoracic spiracles, and in each depression are two club-shaped spines, one of which is twice as long as the other. Epidermis bearing great numbers of dorsal tubular spinnerets, the bases of which spring from very minute figure-of-eight orifices. Anal ring with several (probably ten) hairs, and anterior to it are two rows of large circular multilocular glands (perforated discs).

Second stage of female not observed with certainty.

Larva dark-brown, but externally appearing greyish, being covered with whitish granular wax. Form elliptical, tapering posteriorly to two prominent but rather small tubercles. Length at first about $\frac{1}{80}$in., but later attaining $\frac{1}{50}$in. Antennæ apparently of six subequal joints. Feet moderately strong. The anal tubercles are striated as in the adult, and bear moderate setæ.

Male pupa and adult male unknown.

*Hab.* In Australia, on *Atherosperma moschata* (sassafras). My specimens were sent by Mr. French, from Black Spur, Fernshaw, Victoria. He says, "covers the bark of the tree for yards up, but does not seem to have done any damage."

This species is much nearer to *P. dendrobii*, Douglas, than either of the other two Australian species, *P. eucalypti* and *P. acaciæ*; and, indeed, I am strongly tempted to consider it as a variety only. It differs from Douglas's insect, which is on orchids in Demerara, in the colour of the test, in the absence of spines and the reticulation of the anal tubercles, and in the absence of any "perforated discs" on the cephalic region. It is a pretty insect, and for the present I shall leave it as distinct.

Genus Planchonia.

**Planchonia quercicola,** Bouché. *Asterolecanium quercicola*, Bouché, Ent. Zeit, Stettin, 1851; *Asterolecanium quercicola*, Signoret, Ann. de la Soc. Ent. de France, 1868, p. 279.

In February, 1895, I received from Mr. R. I. Kingsley, of Nelson, some twigs of oak from that place thickly covered with many thousands of Coccids, clearly belonging to the genus *Planchonia;* and on examination they were found to be entirely identical with specimens of *P. quercicola* sent to me in 1881 by Dr. Signoret, from France. I do not propose

to reopen now the discussion of the generic name, as to which I have somewhat fully expressed opinions previously; but I shall merely refer to my remarks on the subject in these Transactions, and in the "Annals and Magazine of Natural History," August, 1895, p. 134.

It is somewhat curious that the occurrence of this pest on the Nelson oak-trees has never before been made known. The twigs which were sent to me were so thickly covered with the little greenish-yellow tests as to be in places invisible. In Mr. Kingsley's letters he informs me that "the owner first noticed the blight about fourteen years ago." It would appear from Signoret (*loc. cit.*) that *P. quercicola* was first observed as an injurious pest about 1836, near Paris, and that certain oaks in the Bois de Boulogne were then practically destroyed by it. I have not found any particular mention of it, either in France or elsewhere, since Signoret wrote, as being especially common or injurious, although it has been reported several times in Europe and in America. It is difficult to look at the Nelson oak-twigs without fancying that the countless thousands of insects on them must greatly damage the trees; and yet all that Mr. Kingsley tells me is that "the upper branches of the trees look somewhat unhealthy." This is after fourteen years' uninterrupted existence. Probably, in Europe there is some parasitic enemy (not generally known) which has kept it in check, and some accidental disappearance of the parasite may account for the prevalence of the *Planchonia* in 1836. In New Zealand, apparently, either there is no parasite, in which case the *Planchonia* will be able to increase indefinitely, or whatever parasite there may be has for a while disappeared, with the consequent outbreak of the Coccids.

Coccids, like other insects, are subject to sudden and injurious increase at irregular intervals. Just in the same way as in England a few years ago there was an extraordinary swarm of the butterfly *Colias edusa*, so in New Zealand at one time *Lecanium hesperidum* was for a few years excessively numerous. In Mauritius and other tropical places *Aspidiotus destructor* broke out at one time with unusual vigour; and we can remember here how in the summer of 1894–95 occurred an alarming increase of *Dactylopius adonidum* in the Hutt Valley, an increase which may perhaps be observed again during the present season. If, therefore, *Planchonia quercicola*, after being fairly quiescent for several years, has of late suddenly started into abnormal activity, we may expect that after a while the checks (whatever they may be) to its increase will again act on it, and it will return to comparative harmlessness.

There remains, of course, the chance that the insect is not

particularly injurious, although, as remarked just now, it is difficult to think this in view of its immense numbers.

In a later letter Mr. Kingsley says, "It does not appear to be increasing. . . . The owner has cut off and burnt from time to time the most-infected branches. . . . One tree at Bishopdale is getting very bad. . . . In the city two trees are infected, but do not yet show signs of decay. . . . Most of the oaks do not appear to be much the worse for it. . . . I do not know of any spraying operations."

In a still later letter (February, 1896) Mr. Kingsley tells me that the trees are beginning to show signs of much damage by this insect, and that it is feared in Nelson that a large proportion of the fine oaks in that district will be most seriously injured.

## Genus Eriococcus.

**Eriococcus spiniger**, sp. nov. Plate XXI., figs. 9–11.

Sac of female white, or with a very faint yellowish tinge; cylindrical; texture very closely felted. Length about $\frac{1}{8}$in.

Sac of male similar to but smaller than that of the female; the texture is perhaps somewhat looser.

Adult female brown or yellowish-brown, filling the sac but shrivelling at gestation. Abdomen ending in two conspicuous but narrow cylindrical anal tubercles, each bearing several short spines and terminated by long setæ. Antennæ of six joints, of which the third and the sixth are the longest. Feet rather slender; tibia a little shorter than the tarsus; all the four digitules are fine hairs. The epidermis bears great numbers of circular spinnerets of two sizes, and also very short fine spiny hairs. On the margin there is a row of strong spines with tubercular bases and blunted ends; these spines are not in a continuous row, being separated according to the segments of the body; each cephalic and thoracic segment bears on each side fourteen to sixteen spines, and each abdominal segment five on each side. From these spines springs a fringe of white tubes, which may be seen within the sac before gestation. The anogenital ring has eight hairs.

Second stage of the female not observed.

Larva yellowish-brown, flattish, elliptical, active; length about $\frac{1}{50}$in. Antennæ and feet normal. The margin bears a row of strong spines as in the adult, but a little more slender, and more acute at the tips.

Adult male unknown.

*Hab.* In Australia, on *Eucalyptus* sp. Mr. Froggatt sent me specimens from Oatley, near Sydney.

The arrangement and size of the marginal spines distinguish this species.

**Eriococcus buxi**, Fonsc., var **australis**, Maskell. Trans. N.Z. Inst., vol xxvii., p. 65.

I have received from Mr. Froggatt some specimens which I shall attach to this species, the principal difference from the type being apparently only the size. The female sac is only about $\frac{1}{25}$in. long, and the male sac still smaller. There seem to be no other distinguishing characters.

*Hab.* In Australia, on *Trachymene billardieri.* Specimens from Sydney.

**Eriococcus paradoxus**, Maskell. Trans. Roy. Soc. South Australia, 1887–88, p. 104.

Specimens received from Mr. G. Quinn, of Adelaide, on *Pittosporum bicolor*, belong to this species. Mr. Quinn says, "This is most destructive on this genus, and the gardener at Government House has burnt a number of the shrubs in consequence, and cut out large quantities of branches of the others." My original specimens were on *Pittosporum undulatum.*

Genus DACTYLOPIUS.

**Dactylopius adonidum**, Linn.

In the "Annals and Magazine of Natural History," August, 1895, I published some remarks on the genus *Dactylopius*, and mentioned an outbreak of *D. adonidum* in the Hutt Valley, near Wellington. I have received specimens from Mr. Froggatt, of Sydney, New South Wales, on *Acacia linifolia*, which I also attach to this species, although in colour they are browner, or redder, than usual. Probably there is no character which serves for differentiating *D. adonidum* from others of the genus better than the sequence of the antennal joints. The insect is apparently omnivorous and cosmopolitan.

**Dactylopius longifilis**, Comstock. Rep. Entom. U.S. Dept. Agric., 1880, p. 344.

This insect occurs on *Croton*, at Calcutta, and in all probability elsewhere in India. Specimens were sent to me by Dr. Alcock, of the Indian Museum.

Genus LACHNODIUS, gen. nov.

As the study of Coccids progresses forms are constantly being found which in some character or characters depart from the generic types hitherto known. Sometimes the variations are but slight and unimportant, and in such cases it has been my rule to leave the species in a known genus without proposing or suggesting its future removal therefrom. Sometimes the abnormal characters have seemed to me fundamental, and I have established new genera on single species;

in these cases, *e.g.*, *Poliaspis*, *Inglisia*, *Sphærococcus*, other species have soon been discovered, which proved the correctness of my view. Sometimes, again, I have reported certain variations and remarked that, if at a future time new insects exhibiting them should be reported, it would probably be necessary to erect a new genus for them.

Such a case as the last occurred in 1891 with the form which I named *Dactylopius eucalypti*. Certain features in this departed from the type of *Dactylopius*, but I preferred to wait for the discovery of some others with similar characters before removing *D. eucalypti* from that genus. Two such forms have now come under review, and I therefore propose to set them apart under the name *Lachnodius*, which will indicate one of the principal characters—the excessive pubescence of the anogenital ring.

### Lachnodius, gen. nov.

Female insects active or stationary; naked, or covered with cottony or mealy or waxy secretion. Body segmented. Antennæ of seven or eight joints, of which the last is not longer than the others. Mentum monomerous. Anal tubercles small or obsolete. Anogenital ring with more than eight hairs.

Male insects normal of *Dactylopinæ*.

The seven-jointed antenna would not in itself be a distinctive character, but the shortness of the last joint, the monomerous mentum, and the hairs of the anal ring are quite sufficient.

**Lachnodius eucalypti.** *Dactylopius eucalypti*, Maskell, 1891, Trans. N.Z. Inst., vol. xxiv., p. 35.

The original description of this insect need not be here repeated. Further notes regarding it will be found in vols. xxv., xxvi., xxvii. of the Transactions. I am satisfied now that the mentum is monomerous.

**Lachnodius lectularius**, sp. nov. Plate XXI., figs. 12–19.

Adult female dark-red or reddish-brown, elliptical, very convex, distinctly segmented; length averaging about $\frac{1}{8}$in., but some specimens seen reach almost $\frac{1}{6}$in. The twig beneath the insect is usually somewhat swollen and widened, and also hollowed out, forming a bed for the insect. The margin is generally somewhat flattened, but this is not noticeable in all specimens. The ventral surface is convex, filling the hollow in the twig, but at gestation the insect becomes itself hollow, and the under-surface then appears as if honeycombed, from the numerous wrinkles formed by the shrinking of the ventral epidermis. Antennæ of seven joints,

of which the third is much the longest, the fourth the next, then the second and first which are subequal, the fifth, sixth, and seventh the shortest and subequal, the seventh probably the shortest of all. Each joint bears some short fine hairs; the first has also one and the second two much longer and thicker. Feet rather strong; the coxa, trochanter, and femur rather thick; the tibia about twice as long as the tarsus; both tibia and tarsus are much wrinkled, and the tarsus is curved; claw moderate; all the four digitules are fine hairs. There are several short spiny hairs on each joint of the foot, and on the trochanter are two very long and thick. Rostrum small; mentum monomerous, subcircular; setæ very short. The abdomen terminates in a curve without any appearance of anal tubercles, nor are there any special terminal hairs. Anal ring large, compound, bearing from twenty to twenty-four long strong hairs. The margin of the body has a series of long and strong spines set closely together; each spine springs from a projecting tubular base, which is ringed. Epidermis bearing many short fine hairs, and near the cephalic and abdominal extremities are two curved series of stronger spiny hairs, about sixty in each. On the abdominal segments there are great numbers of very minute subcircular marks which seem like the orifices of spinnerets, but of the twenty-five specimens observed none exhibited either cotton or wax. In some specimens there are two strong short conical spines set close together between the antennæ, but these are apparently not constant.

Female of the second stage yellow or yellowish-brown, elliptical, convex, segmented; length about $\frac{1}{8}$in. Antennæ of six joints, which are proportionately thicker than in the adult; of these the third is much the longest. Feet, marginal spines, and anal ring as in the adult; but instead of one pair of strong conical spines there are many such pairs—apparently twenty-four in all.

Larva yellow, subcircular or broadly elliptical, slightly tapering posteriorly; length about $\frac{1}{50}$in. Antennæ short, thick, with six subequal joints. Margin bearing a series of strong conical spines set closely together; these are proportionately shorter than those of the adult, but their points are produced into very long fine threads forming a delicate fringe.

*Hab.* In Australia, on *Eucalyptus rostrata*. Mr. French has sent me a number of specimens, and says, "It does great damage to young trees at Mooroopna, Goulburn River, Victoria."

*L. lectularius* may be distinguished from both the preceding and the following species by the much longer marginal spines both in the adult and the larval stages. From *L.*

*hirtus* it likewise differs in its very much slighter dorsal pubescence. I am not prepared to say that in its natural state it may not produce some cotton, although none of my specimens has any.

I find I have omitted to say that the adult male and the male pupa are unknown.

**Lachnodius hirtus**, sp. nov. Plate XXII., figs. 1–9.

Adult female dark-purple, but covered with a quantity of very short white filaments rising from the dorsal hairs, so that the general appearance is grey; form subglobular; diameter about ¼in. or ⅓in. before gestation. Dorsum covered with great numbers of short but rather strong brown hairs, which give it a woolly appearance. Antennæ of seven joints, of which the third is the longest, then the fourth and second, next the first, and the last three are the shortest and equal; the last joint is not elongated. All the joints bear a few hairs, the last having several. Feet long and strong; coxa, trochanter, and femur large and thick; tibia cylindrical, three times as long as the tarsus, and bearing on the inner edge several strong spines and at the tip two spurs; tarsus short and thick, with two slender spines on the inner edge; claw short and broad. There are no digitules either on the tarsus or on the claw. The anogenital ring has about twenty hairs. The mentum is large and monomerous. The abdominal extremity is rather truncate, and there are no anal tubercles; but two of the hairs on the extreme margin are a little longer than the rest.

Second stage of the female not observed.

Larva reddish- or yellowish-brown, active, elongated, tapering posteriorly; length about $\frac{1}{75}$in. Abdomen ending in two very minute anal tubercles, each bearing a long seta. Antennæ of six rather thick joints, of which the third and the sixth are the longest; on the last joint are several hairs, of which one is much longer than the rest. Feet long and rather slender; tibia rather more than half as long as the tarsus; claw very small and slender. There are four digitules, all of which are fine hairs. The dorsum is covered with many fine hairs, and on the margin there is a row of strong spines, of which the two which are between the anal tubercles are double.

The male pupa is covered by a white cylindrical sac of white cotton, about ⅛in. long. The enclosed insect has not been observed.

Adult male unknown.

*Hab.* In Australia, on *Acacia* sp. My specimens are from Mr. Froggatt; I believe the locality to be Thornley, near Sydney. As, however, the adult female is quite apt for

wandering there will probably be many plants and places where it may be found.

The excessive pubescence and the strongly spined and spurred tibia will distinguish this species.

Genus SPHÆROCOCCUS.

**Sphærococcus inflatipes**, Maskell, var. **simplicior**, var. nov.

Adult female occupying a small depression in the bark, and covered by a flattish subcircular test, which is scarcely raised above the bark, and, being of the same substance and colour, is very inconspicuous, seeming as if only a small blister.

Adult female of the general form of the type, subcircular, slightly depressed dorsally and slightly convex ventrally; diameter about $\frac{1}{30}$in. dorsally. The antennæ are much more atrophied than in the type, the joints being quite confused, and the whole organ appearing more tubercular. The two anterior pairs of feet are also much smaller than in the type, being, indeed, in some cases scarcely to be made out; the large and long posterior pair, on the other hand, are perhaps a little more exaggerated than those of the type, and the claw is much more distinct. The dorsal region bears, as in the type, very great numbers of small oval markings and very short fine hairs, but instead of a ring of strong spines encircling the whole there are only about six at the posterior extremity, with three or four much smaller ones at each side of them. The ventral hairs and orifices are as in the type.

This variety is distinguished by the very inconspicuous test, by the smaller antennæ and anterior feet, and by the difference in the dorsal spines.

*Hab.* In Australia, on *Eucalyptus viminalis*. Specimens sent by Mr. French from Melbourne. These specimens were accompanied by numbers of *Aspidiotus eucalypti*, var. *comatus* (of this paper); and in examining a twig it is necessary to carefully distinguish the puparia of the *Aspidiotus* from the tests of the *Sphærococcus*.

**Sphærococcus obscuratus**, sp. nov. Plate XXII., figs 10–17.

Adult female covered by a swelling of the bark of the tree, which is frequently much coated with black fungus, and is very inconspicuous. On lifting off the bark the insect is seen lying on the wood in the cavity; sometimes it is partially or almost wholly enclosed in the exuviæ of the second stage, sometimes the upper portion of the exuviæ is lifted away with the bark and the lower half forms a cushion on which the insect rests.

Adult female dull-red or yellowish-red or brownish, globular or subelliptical; diameter about $\frac{1}{25}$in. Abdomen distinctly segmented. Antennæ variable; in some species they are almost if not quite wanting, being reduced to a mere tubercle; in others they are short and swollen, with very confused joints (three? or six?) difficult to separate. Feet entirely absent. Mentum distinctly biarticulate, rather large, and bifid at the tip. There are four large thoracic spiracles, each surrounded by a ring of circular glands. The epidermis bears many small simple circular spinneret-orifices; and on the last three abdominal segments are some larger orifices. Anogenital ring small, simple, hairless. The whole body is much wrinkled; and on the dorsal abdomen there are four very strong transverse chitinous bands, broad in the middle and tapering to points at the ends; the outer margin of each band is smooth, the inner bearing on each side from four to eight conspicuous crenulations. On the cephalic and thoracic margins are some short spines.

The female of the second stage is circular, flattish dorsally and ventrally, or subglobular; diameter about $\frac{1}{20}$in., being thus rather larger than the adult. The colour is a dull-yellow or grey. The rostrum and mentum are large; the antennæ nearly completely atrophied. Feet absent. The abdominal region has not been accurately observed, but I see no trace of chitinous bands.

Larva subelliptical, flattish, active; length about $\frac{1}{87}$in. Abdomen ending in two conspicuous protruding anal tubercles bearing spines and setæ. Antennæ of six rather thick and somewhat confused joints, of which the fourth and fifth are the shortest. Feet also rather thick; all the four digitules are fine hairs. In its later state the larva becomes more elongated.

Male pupa enclosed in a felted, yellowish, cylindrical sac which has a small orifice at the posterior end; length of the sac about $\frac{1}{25}$in. I have not observed the pupa itself.

Adult male unknown.

A minute scarlet Gamasid mite, about $\frac{1}{150}$in. in length, is very active in the burrows of this Coccid. I do not know how far it may be occupied in feeding on the *Sphærococcus*, but possibly the difficulty which I have found in getting any quite complete specimen of the second stage may be due to the action of this mite. I have not observed any eggshells in the cavities examined, though the insect is not, as far as I can make out, viviparous; and this again may be due to the appetite of the Gamasid.

*Hab.* In Australia, on *Acacia longifolia* and on *Eucalyptus obtusiflora*. Specimens on both plants have been sent by Mr. Froggatt from Hornsby, near Sydney.

This species, in the wrinkled abdomen and the transverse markings, approaches both to *S. bambusæ*, Mask., 1892 (Sandwich Islands), and to *S. melaleucæ*, Mask., 1893 (Australia); but it is very clearly distinct from both. The broad and conspicuous chitinous bands are a quite distinctive character.

Genus ICERYA.

**Icerya nudata**, sp. nov. Plate XXIII., figs. 1–6.

Adult female yellowish-red in the anterior regions and brick-red on the abdomen; covered with thin white meal, but not forming any ovisac. Body very thick, with a convex dorsum and swollen ventral region; the dorsal and ventral portions are separated by a lateral ridge. Antennæ of ten joints, of which the last, the first, and the third are the longest, then the second and fourth, the rest shorter and equal; a few hairs on all the joints, and on the tenth are four much longer than the others. Feet black and rather strong; all the joints, coxa, trochanter, femur, tibia, and tarsus bear on the inner side numerous rather strong spines; the tarsal digitules are short fine hairs, digitules of the claw represented by short thick bristles. The epidermis is covered with many very fine short hairs interspersed with very minute circular multilocular orifices, and along the lateral ridge there are also many rather larger ones; also on this ridge are many rather longer hairs, which are most numerous at the abdominal extremity. The length of the insect is about ¼in., the height at gestation about ⅛in.

This insect is viviparous, and a number of larvæ can be found within the body, so that an ovisac is not required.

Larva dark-red, the feet and antennæ black. The form is normal of the genus, elliptical, slightly tapering; length about $\frac{1}{50}$in. Antennæ of six joints, the last of which is about as long as the third, fourth, and fifth together; it is regularly clavate, without any basal swelling or median constriction, and bears four very long hairs. The abdomen ends with the usual six small tubercles, from which spring very long setæ, almost as long as the body. The whole margin also bears numerous setæ, of which those on the anterior thorax are the longest, diminishing gradually posteriorly except the pair just anterior to the terminal six, which are as long as those on the thorax. Epidermis bearing circular multilocular orifices which are disposed in longitudinal rows; from these is produced some white cotton, usually visible in patches on the dorsum. Feet presenting no special features.

Female of the second stage, and male, unknown.

*Hab*. In Australia, on *Cosmos*, *Verbena*, &c. Mr. Olliff sent me specimens from Sydney, stating that the insects were "said to be doing very considerable injury."

I have been unable to attach this insect to any known species. In the absence of an ovisac and the consequent viviparous propagation it approaches *I. rosæ*, Riley and Howard, 1890; but both adult and larva differ from that species, of which I have reported a variety *australis* in 1893. There is an insect, *I. palmeri*, Riley and Howard, 1890, of which the adult female is not yet known, and I at first thought that it might be this Sydney one; but the larva of *I. palmeri* has the last joint of the antenna conspicuously swollen at the base and constricted in the middle; and the larval marginal hairs also differ.

Since 1892, when I inserted in my paper (Trans. N.Z. Inst., vol. xxv., p. 246) a list of all known *Iceryæ*, the following have been found:—

*I. rosæ*, var. *australis*, Maskell, 1893, Australia;
*I. crocea*, Green, MS., Ceylon;
*I.* sp., Cockerell, MS., New Mexico;
*I. nudata*, Maskell, Australia.

The outline of this insect is much like that of *Cœlostoma immane*, Mask., the gigantic Coccid from central Australia; but, apart from size and colour, the antennæ of the two show that they belong to different genera.

The figures 1 and 2 of my Plate XXIII. are taken from tracings of sketches sent to me by Mr. Olliff. Since the foregoing description was written intelligence has come of the lamented death of my friend, an event which all who are interested in science, especially in this quarter of the globe, must very deeply deplore. An earnest and energetic worker on the natural history of Australasia, his removal while still in the prime of life leaves a gap which may not be easily filled. Personally I have many recollections of pleasant and useful correspondence with him, although we never actually met; and I have been frequently indebted to him for hints, information, and other kinds of help, always promptly and generously given. Whilst, therefore, I mourn his loss as a co-operator in our branch of science, I must also regret the untimely loss of a friend.

**Icerya rosæ**, var. **australis**, Mask., 1893. Plate XXIII., figs. 7–11.

Specimens of this insect received lately from Mr. Froggatt do not show the rows of yellow spots noted in my description (Trans. N.Z. Inst., vol. xxvi., p. 101). In other respects the specimens agree with my former ones. It is possible that the spots may be noticeable only at certain seasons. But I find also that in the specimens in my cabinet the spots have disappeared, although when alive they were quite conspicuous. It may therefore be also possible that the type of *I. rosæ* in

Florida may, when seen in the living state, also exhibit the spots. The differences which I noted in the Australian variety —the antennal joints of the adult and the arrangement of the larval hairs—will still stand good, and I shall leave it as a valid variety.

In November, 1895, Mr. Froggatt sent me a number of specimens of the adult male of this species. I believe I am right in saying that, up to the present time, no male *Icerya* has been reported except that of *I. purchasi*, Mask. It is therefore interesting to record now that of *I. rosæ*.

But after a careful examination I am unable to detect any characters of importance which may distinguish this male from that of *I. purchasi*. Probably one naturally expects to differentiate a new thing from what is already known; moreover, one would suppose that a male of one species should not resemble entirely that of another. In all the *Coccidæ*, however, it is difficult to separate the males; whether amongst the Diaspids, or the Lecanids, or the Monophlebids, they are all exceedingly alike. In *Sphærococcus* I have been obliged to postpone giving generic characters for the male precisely because that genus exhibits just what no other does—a marked difference amongst the males. I gave in my "Scale-Insects of New Zealand," 1887, plate ii., fig. 3, some type-forms indicating a means of separating the males of one *group* from those of another; but there is nothing that I know of at present which may serve in a similar way as between males of any particular genus. Probably there is such a thing, if one could discover it, because a male of, say, *Aspidiotus nerii* would not couple with a female of *Aspidiotus aurantii*, or a male of *Ctenochiton viridis* with a female of *Ctenochiton elæocarpi*: but I do not yet know what it is.

However, I append a description of the male of *I. rosæ* var. *australis*, premising that the general appearance seemed to me to be so near to that of *I. purchasi* that I wrote to Mr. Froggatt asking him if he were quite sure as to the collection of his specimens. In reply he assured me that he found both the adult females and the male cocoons on the same plant, and that the males which he had sent me had hatched out of these same cocoons in his own boxes. He also sent me a further supply of both females and cocoons together.

The male larva before changing to the pupa is very dark red, elliptical, slightly convex; length about $\frac{1}{16}$in. The antennæ and feet are black. This larva is enclosed in a sac of thin white or slightly-yellowish wax, which is surrounded by much white cotton, and many of these sacs or cocoons are frequently massed together on a leaf. The antennæ have six joints, of which the first three are subequal, the next two shorter and equal, the last about as long as the fourth and

fifth together; each joint has a few hairs, and the last has two rather long. Feet rather long and slender, with some hairs; there is no tarsal digitule, and only one short bristle on the claw. The margin of the body bears a row of rather long hairs, and many similar hairs are on the dorsum; and at the posterior extremity there are six long setæ with tubercular bases. The epidermis is covered with numerous large circular multilocular spinneret-orifices. The eyes are small, tubercular. Rostrum large; mentum biarticulate.

The adult male is dark-red; length about $\frac{1}{18}$in. The wings are dark-grey; nervure red; there are also two longitudinal white streaks. Abdomen distinctly segmented, and each segment bears some rather long hairs. The abdomen terminates in two cylindrical processes, which in life are turned upwards, and beneath and between which is the short subconical sheath from which issues the penis; each of these processes bears four long setæ. Eyes prominent, numerously facetted, nearly black. Antennæ black, with ten joints, of which the first two are tubercular, the next seven elongated and compressed in the middle, the last subcylindrical. All are about the same length except the two first, which are shorter and equal; the second bears two shortish hairs, the last has several much longer and irregularly arranged, and the seven intermediate ones bear each two sets of long hairs arranged in rings; so that the whole antenna has a plumose appearance. Feet long and slender, black; the tibia is twice as long as the tarsus; all the joints are hairy. There is only one digitule, which is a short fine bristle on the claw.

The original food-plant of this species I gave as *Hakea gibbosa*, and in 1893 Mr. Froggatt remarked that the insect was rare; but he tells me now that he has found it also on *Goodenia ovata*, but still in the same locality, near Sydney.

A comparison with the description and figures which I gave of the male of *I. purchasi* in vol. xix. of our Transactions, and also in my "Scale-Insects of New Zealand," 1887, will demonstrate the exceedingly close similarity between the males of the two species.

### Genus Tachardia.

**Tachardia decorella**, Maskell, Trans. N.Z. Inst., 1892, p. 247.

In May, 1895, I received from Dr. Alcock, Superintendent of the Indiam Museum, Calcutta, some specimens of Coccids stated to attack "tea- and forest-trees in India." They turned out, greatly to my surprise, to be *Tachardia decorella*. As no locality was given, and the "forest-trees" were not named, I could not form any definite judgment as to the likelihood of these insects being native to India or introduced from Austra-

lia; but the forest-trees being spoken of merely in general terms makes it seem most probable that they are indigenous to both countries. At some future time the species may be found in other tropical or subtropical lands.

## INDEX TO PLATES XVI.-XXIII.

### PLATE XVI.

*Larval Characters of* Coccidæ.

Fig. 1. *Diaspidinæ*: *a*, abdomen; *b*, antenna; *c*, foot.
Fig. 2. *Lecaninæ*: *a*, abdomen; *b*, abdomen after pressure; *c*, antenna; *d*, foot.
Fig. 3. *Hemicoccinæ*: Letters as above.
Fig. 4. *Acanthococcinæ*: Letters as above.

### PLATE XVII.

*Larval Characters of* Coccidæ.

Fig. 1. *Dactylopinæ*: *a*, abdomen of *Dactylopius*; *b*, abdomen of *Ripersia*; *c*, antenna; *d*, foot.
Fig. 2. *Idiococcinæ*: *a*, abdomen of *Cylindrococcus*; *b*, abdomen of *Sphærococcus*; *c*, antenna; *d*, foot.
Fig. 3. *Monophlebinæ*: *a*, abdomen of *Monophlebus*; *b*, abdomen of *Icerya*; *c*, antenna; *d*, foot.
Fig. 4. *Brachyscelinæ*: *a*, abdomen of *Brachyscelis*; *b*, abdomen of *Tachardia*; *c*, antenna; *d*, abnormal antenna of *T. melaleucæ*; *e*, foot.

### PLATE XVIII.

Fig. 1. *Aspidiotus hakeæ*, insects on bark.
Fig. 2. " abdomen of adult female.
Fig. 3. posterior extremity of second pellicle.
Fig. 4. diagram of larval pellicle.
Fig. 5. larva (early).
Fig. 6. second stage of male.
Fig. 7. *Aspidiotus virescens*, insects on leaf.
Fig. 8. " puparia, female and male.
Fig. 9. " abdomen of adult female.
Fig. 10. " margin of adult female, enlarged.
Fig. 11. *Aspidiotus eucalypti*, var. *comatus*, abdomen of adult female.

### PLATE XIX.

Fig. 1. *Mytilaspis acaciæ*, female and male puparia on separate pieces of bark.
Fig. 2. " abdomen of adult female.
Fig. 3. *Mytilaspis banksiæ*, insects on leaf.
Fig. 4. " adult female.
Fig. 5. " abdomen of adult female.
Fig. 6. *Mytilaspis melaleucæ*, abdomen of adult female.
Fig. 7. *Chionaspis prunicola*, var. *theæ*, insects on leaf.
Fig. 8. " " puparia, female and male.
Fig. 9. *Chionaspis spartinæ*, var. *natalensis*, insects on grass.
Fig. 10. " " puparia, female and male.
Fig. 11. " " abdomen of adult female.

## Plate XX.

Fig. 1. *Pulvinaria thompsoni*, insects on branch.
Fig. 2. " female and sac, enlarged.
Fig. 3. " diagram of adult female.
Fig. 4. " antenna of adult female.
Fig. 5. " last joint of antenna, enlarged.
Fig. 6. " foot of adult female.
Fig. 7. " spiracle and marginal spines of adult female.
Fig. 8. " test of male pupa.
Fig. 9. Undetermined Hemicoccid, insects on leaf, second stage.
Fig. 10. " insect, second stage, enlarged.
Fig. 11. " diagram of female, second stage.
Fig. 12. " antenna of female, second stage.
Fig. 13. " foot of female, second stage.
Fig. 14. " marginal spines of female, second stage.
Fig. 15. " abdominal extremity of female (after pressure).
Fig. 16. " larva.
Fig. 17. " antenna of larva.

## Plate XXI.

Fig. 1. *Prosopophora atherospermæ*, insects on bark.
Fig. 2. " adult female in test, enlarged.
Fig. 3. " test of male pupa.
Fig. 4. " diagram of adult female.
Fig. 5. " antenna of adult female.
Fig. 6. " diagram of abdominal extremity of adult female.
Fig. 7. " spiracular spines of adult female.
Fig. 8. " perforated discs and figure-of-eight spinnerets.
Fig. 9. *Eriococcus spiniger*, diagram of female.
Fig. 10. " antenna of female.
Fig. 11. " marginal spines of female.
Fig. 12. *Lachnodius lectularius*, insects on twig.
Fig. 13. " adult female, enlarged.
Fig. 14. " antenna of adult female.
Fig. 15. " foot of adult female.
Fig. 16. " abdominal extremity and anal ring of adult female.
Fig. 17. " marginal spines of adult female.
Fig. 18. " larva.
Fig. 19. " marginal spines of larva.

## Plate XXII.

Fig. 1. *Lachnodius hirtus*, insects on branch.
Fig. 2. diagram of hairs of female.
Fig. 3. antenna of female.
Fig. 4. foot of female.
Fig. 5. anal ring of female.
Fig. 6. rostrum and mentum of female.
Fig. 7. larva.
Fig. 8. antenna of larva.
Fig. 9. " marginal spines of larva.
Fig. 10. *Sphærococcus obscuratus*, insects in blisters on bark.
Fig. 11. " some blisters cut open.

Fig. 12. *Sphærococcus obscuratus*, diagram of adult female.
Fig. 13. „ antenna of adult female.
Fig. 14. wrinkles and chitinous bands of abdomen of adult female.
Fig. 15. larva.
Fig. 16. antenna of larva.
Fig. 17. gamasid mite parasite.

PLATE XXIII.

Fig. 1. *Icerya nudata*, adult female, side view.
Fig. 2. „ adult female, dorsal view.
Fig. 3. antenna of female.
Fig. 4. foot of female.
Fig. 5. diagram of larval spinnerets and marginal hairs.
Fig. 6. antenna of larva.
Fig. 7. *Icerya rosæ*, var. *australis*, diagram of male larva.
Fig. 8. „ antenna of male larva.
Fig. 9. „ adult male.
Fig. 10. „ abdominal extremity of male.
Fig. 11. „ antenna of male.

## ART. XXXIX.—*Contributions towards a Monograph of the* Aleurodidæ, *a Family of Hemiptera-Homoptera.*

By W. M. MASKELL, Registrar of the University of New Zealand, Corr. Mem. Roy. Soc. of South Australia.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

Plates XXIV.-XXXV.

THE attention of systematic entomologists has perhaps been less directed to the *Aleurodidæ* than to any other family of insects. The bibliography attached to this paper contains, indeed, a fair number of names, but the majority of these writers have either simply repeated the phrases of their predecessors, or made only quite trivial observations, or manifested but slight acquaintance with the family. The number of species reported is exceedingly small; and yet these insects are found in almost every country, and infest a great variety of plants, and it is certain that a little trouble on the part of collectors and observers would discover a large number of species now quite unknown. In this paper I shall include more than twenty forms which I believe to be new. These forms have come under my notice in connection with my studies of the homopterous family of the *Coccidæ*, most of them having been sent to me as specimens of that family. Were I able now to do any collecting myself in New Zealand (which unfortunately is not the case) I am sure that I could

increase the list of species even in this country; and it stands to reason that in other lands there must be many *Aleurodidæ* awaiting discovery. I do not hold the opinion that the interest attached to any order of insects is to be measured by the number of genera and species which it at present contains, any more than by the size and colours of the insects comprised in it. Possibly the publication of these notes may induce entomologists to devote more attention to these minute and interesting, and by no means unimportant, organisms.

At the outset I must say that I am conscious of what may perhaps be considered a serious defect in this paper. I mean that in the majority (indeed, nearly all) of the new species which are herein described and figured I have been unable to report anything concerning the adult stage of the insects. It may be thought that an account of the larvæ and pupæ, without a description of the imagines, is too imperfect for scientific completeness and accuracy, and is therefore of little use to science. Probably such a view might be correct as regards the greater number of insect orders, and I would myself admit its justice even as regards the *Coccidæ*, for in most cases a knowledge of the immature stages of insects is not much of a guide to their adult form. But in the *Aleurodidæ* the case is different; and I venture to put forward the following reasons for the proceeding which I have adopted:—

1. The *Aleurodidæ* differ but very slightly in their adult stage. The form of the body, of the feet and antennæ, of the rostrum, of the genitalia, is but little varied in this stage, and the differences which may exist require exceedingly minute observation for their detection. The presence or absence of spots on the elytra, and a very minute difference in the venation, are really about the only characters for differentiation.

2. But, on the other hand, the form of the larva and the pupa, their colours and markings, and their secretions, vary most considerably. A glance at the figures accompanying this paper will very readily exhibit this fact.

3. It is precisely in the larval and pupal states that these insects inflict injury upon plants. Although (differing in this from the *Coccidæ*) both sexes possess rostra and digestive organs in the adult state, yet it does not appear that in that condition they damage plants; that is done by the larvæ and pupæ. It appears, therefore, more important, in the domain at least of economic entomology, to bring out the differences in these immature stages, so that cultivators may recognise the insects in those stages in which they more particularly affect plants.

4. The point just mentioned has been probably the reason why most of the species which I have received have been sent to me as larvæ or pupæ. *Aleurodidæ* in these states are often

exceedingly like *Coccidæ*; so like that even an entomologist requires close examination to detect the differences. Gardeners, therefore, and collectors, and museum authorities, and others, not pretending to exact knowledge of the Homoptera, finding plants covered perhaps with a multitude of scale-like insects, and not connecting them with the little white flies hovering over the branches, send them for identification as *Coccidæ*, and it is almost impossible within reasonable time to procure from the collectors the adults, which, indeed, they can scarcely recognise.

5. Probably the best means by which one could arrive at some knowledge of the adults is the publication of such a paper as the present one as a guide to collectors.

The foregoing reasons seem to me sufficient to explain my motive in this paper.*

## BIBLIOGRAPHY.

The following list contains the names of all the authors who have treated of the *Aleurodidæ*, as far as I am aware, omitting such brief notices as may be found scattered in publications like the *Entomologist*, *Gardeners' Chronicle*, *Insect Life*, &c., not containing scientific descriptions or observations. With regard to the years 1894 and 1895, the information available to me is not yet complete. As regards early writers, such as Réaumur, Linnæus, Geoffroy, &c., it is to be noted that they class these insects under such varied genera as *Papilio*, *Tinea*, *Chermes*, &c.:—


1740 (about). *Réaumur*, Mémoires, tom. ii., mem. 7.
1764. *Geoffroy*, Hist. abr. des Insectes, p. 509.
1764–90. *Linnæus*, Syst. Nat.; and *Ræmer*, Notiz.
1795–1807. *Latreille*, Mag. Encycl., tom. ii., p. 304; and Genera Ins., tom. iii., p. 174.
1800–30. *Tigny*, *Walckenaer*, *Kirby and Spence*; observations of no special importance.
1801. *Schrank*, Fauna Boica, ii., 1, 147, 1273.
1829. *Stephens*, Catal. of Brit. Ins., p. 267.
1833. *Doubleday*, Entom. Mag., vol. i., p. 313.
1835. *Haliday*, Entom. Mag., vol. ii., p. 119.
1835. *Burmeister*, Handb. der Entom., tom. ii., p. 82.
1840–41. *Blanchard*, Ins. Voyage to Chili, p. 319.
1840. *Westwood*, Introd. to Mod. Class. of Ins., vol. ii., p. 442.


* In the *Entomologists' Monthly Magazine* for August, 1895, is an article by Mr. J. H. Durrant, F.E.S., entitled "A Protest against giving Names to the Preparatory Stages of Insects." Whatever may be the force of the argument therein as to the Lepidoptera, Diptera, Hymenoptera, and Coleoptera, I venture to think that an exception may be made as to the Homoptera.

1841. *Guérin*, Iconog. du Règne Anim., p. 373.
1843–48. *Amyot* and *Serville*, Hemipt., 614.
1840–43. *Boyer de Fonscolombe*, *Hartig*; unimportant observations.
1846. *Curtis*, Gard. Chronicle, p. 284.
1849. *Bärensprung*, Zeit. fur Zool., Alton und Burm., p. 176.
1850. *Haldeman*, Journ. Amer. Soc. Sci. and Arts, 2nd ser., p. 108.
1851. *Bouché*, Entom. Zeit. Stett., tom. xii., p. 108.
1851. *Walker*, Catal. Homopt. in Brit. Mus.
1855. *Hegeer* (*Heeger?*), Sitzungsber. der Akad. Wissensch., tom. xviii., 35; Beitrag zur Naturges. der Insekt., p. 3.
1856. *Westwood*, Gard. Chronicle, p. 852.
1857. *Koch*, Pflanzenläuse, p. 324.
1859. *Hegeer* (*Heeger?*), Beitrag zur Naturges. d. Ins., pp. 14, 111.
1863. *Gerstaecker*, Handb. des. Zool., tom. ii., p. 340.
1886–67. *Frauenfeld*, Verh. Zool.-Bot. Gesells., Wien, p. 793.
1867–68. *Signoret*, Ann. de la Soc. Entom. de France, p. 369.
1867. *Löw*, Verh. Zool.-Bot. Gesells., Wien, p. 746.
1878. *Douglas*, Ent. Mo. Mag., vol. xiv., p. 230.
1879. *Douglas*, Ent. Mo. Mag., vol. xvi., p. 43.
1880. *Douglas*, Ent. Mo. Mag. vol. xvii., p. 89.
1880. *Künow*, Entom. Nachricht., vi., p. 46.
(?) *Shimer*, Trans. Amer. Entom. Soc., i., p. 281.
1881. *Signoret*, Ann. de la Soc. Ent. de France, p. 158.
1883. *Signoret*, Ann. de la Soc. Ent. de France, p. 63.
1884. *Douglas*, Ent. Mo. Mag., vol. xx., p. 215.
1886. *Douglas*, Ent. Mo. Mag., vol. xxiii., p. 164.
1881–86. *Ormerod*, Injurious Insects; Reports, &c.
1886. *Westhoff*, Jahresber. Zool.-Westfäl.-Verein, p. 56.
1886. *Goldi*, Mittheil. Schweitz. Entom. Gesellsch., vii., p. 247.
1888. *Karsch*, Entom. Nachricht., xiv., p. 31.
1888. *Douglas*, Ent. Mo. Mag., vol. xxiv., p. 265.
1889. *Douglas*, Ent. Mo. Mag., vol. xxv., p. 256.
1889. *Maskell*, Trans. N.Z. Inst., vol. xxii., p. 171.
1891. *Douglas*, Ent. Mo. Mag., vol. xxvii., pp. 44, 322.
1892. *Douglas* and *Morgan*, Ent. Mo. Mag., vol. xxviii., p. 29.
1893. *Cockerell*, Ent. Mo. Mag., vol. xxix., p. 105.
1893. *Riley* and *Howard*, Insect Life, pp. 219, 314.
1894. *Douglas*, Ent. Mo. Mag., vol. xxx., pp. 40, 78, 1[illegible]

1895. *Douglas*, Ent. Mo. Mag., vol. xxxi., pp. 68, 97, 117.
1895. *Lewis*, Journ. Quekett Micr. Club, p. 88.

Mention must also be made of a paper by Dr. Signoret (Ann. de la Soc. Entom. de France, 1879), in which the author establishes a new genus *Spondyliaspis*, containing three species, from Queensland, Australia, which he proposes to attach to the *Aleurodidæ*. But there is no doubt that these insects belong to the family *Psyllidæ*, and are closely allied to some which are described by Dobson in the "Proceedings of the Royal Society of Tasmania," 1850 (vol. i., 1848–50, p. 235 *et seqq.*). Drawings of the waxy coverings of these insects and of pupæ sent to me by Dr. Signoret in 1882, and compared both with Mr. Dobson's figures and with actual specimens from Australia in my cabinet, satisfied me on this point, and Dr. Signoret subsequently agreed with me. In *Insect Life*, 1893, p. 219, Messrs. Riley and Howard say that *Spondyliaspis* was "afterwards found to fall before Maskell's *Inglina* [misprint for *Inglisia*], erroneously supposed by the latter to belong to the *Coccidæ*." There is not the slightest doubt that *Inglisia* is a Cóccid, and it is not at all similar in any respect to *Spondyliaspis*. The sentence just quoted is regrettable.

## Order HEMIPTERA.

### Sub-order HOMOPTERA.

### Family ALEURODIDÆ.

Insects infesting plants; furnished in the adult state with four wings in both sexes; possessing also in the adult state in both sexes rostra and digestive organs. Eyes sometimes entire, sometimes divided, but more usually reniform, with a larger and a smaller segment, of which the smaller is anterior; antennæ of seven joints; feet with dimerous tarsi terminated by three claws, of which one is smaller than the other two. Eggs with a short peduncle or stalk.

The wings of the adults are usually covered with more or less of a white powdery matter, from which the name of the family has been established (ἄλευρον = flour).

It has already been observed that there is little difference amongst the adults of this family, except as regards the wings, which in some species are immaculately white and in others more or less spotted, patched, or banded. The minute distinctions, which may be detected by close examination, in the relative lengths of the antennal joints or of the feet, or in the divisions of the eyes, seem to be unimportant; and the colours of the bodies, which vary somewhat with the age of the specimens, may perhaps be looked on as often subject to the

"personal equation" of an observer. Plates XXIV., 1, and XXIV., 2, of this paper are designed to show the details of structure which may be taken as sufficiently constant throughout the family, as far as the adults are concerned.

The adults may therefore be said to be practically always yellowish or tinged with red or brown; the wings carried flat when at rest and not extending much beyond the abdomen; forewings usually rounded, pure white or spotted, patched or banded with brown or red; hindwings smaller, also rounded; vein in the forewing single, median, with one basal branch (*Aleurodes*), or a basal and a terminal branch (*Aleurodicus*); vein of hindwing single, median, with one basal branch*; head small, transverse, oblique beneath, slightly convex above, anteriorly rounded; eyes two, red or brown, not prominent, more or less reniform or sometimes divided, the anterior portion the smallest; a small simple circular ocellus close to each eye; antennæ anterior to the eyes, consisting of seven joints, of which the two first are short and simple, the rest long, slender, and numerously ringed; rostrum projecting from the under-side of the head, composed of a single (?) conical joint, at the apex of which are three tubular setæ, and from the base of which (beneath) springs a long subcylindrical mentum, of three segments,† which is free in all its length, and frequently extends beyond the thorax; the tip of the mentum is usually dark-coloured; thorax short, the pro-, meso-, and meta-thorax about equal; abdomen moderate, roundly tapering, terminated by the genitalia, and bearing dorsally a minute tubercular organ‡ (described more particularly below) consisting of an orifice, an operculum, and a lingula; genitalia usually dark-coloured; genitalia of female conical or subconical; genitalia of male forcipate; feet slender, long, tarsi dimerous, terminal claws three, of which the middle one is the shortest.

The eggs, which are elliptical, pedunculated and usually yellow or orange in colour, are produced in great numbers, but seemingly only once in a year, although it would appear (according to Réaumur and Hegeer) that the period required for hatching is ten days or a fortnight.

The larva, as soon as it is hatched, fixes itself on the leaf, and, as a rule, never afterwards moves from its position. In

* Signoret thinks that perhaps there may be two or three "invisible" veins in the forewing.

† Westwood (Introd. to Mod. Class. of Ins., vol. ii., p. 442) says, "promuscis 2-jointed"; but it seems clear that he did not distinguish the mentum. See his figure 118, 4.

‡ Westwood (*loc. cit.*) says, "Abdomen neither tuberculed nor corniculate"; surely an error. He likewise says of the feet—"ungues two," but in his figure he shows three.

this stage the differentiation of species can be fairly commenced. In general form and outline there is little distinction, the larvæ being (as far as is at present known) always elliptical and flattish; but in the colours, in the character of the secretions and fringes, in the arrangement, or the absence of hairs, spines, pustules, or other features, it is possible to note clearly enough the specific differences, as will be seen from the descriptions and figures given in this paper. Generally, in the earliest form of the larva, it is simply a thin, flattish, elliptical, motionless object in which no trace of organs is visible with the exception of an orifice near one extremity, which in this paper I term the "vasiform orifice," and of which I shall speak more particularly presently. As the larva grows, indications of the rostrum appear, and still later rudiments of feet and antennæ may be faintly traced. According to the two authors mentioned above, the larva remains in this state only for about a fortnight, and then, without change of position or discarding of its envelope, passes into the pupa stage. This is the view adopted by most writers on the family, and it seems to be, as a general rule, correct; so that there is extreme difficulty in recognising, except perhaps by size, the difference between a late larva and a pupa, and most authors seem to speak indiscriminately of both, under the names of "early larva," "adult larva," "nymph," &c., these stages being apparently usually distinguished by the more or less definite outlines of the rudimentary feet and antennæ. In 1889 (Trans. N.Z. Inst., vol. xxii.) I pointed out that in *Aleurodes asplenii*, otherwise sufficiently normal as regards the question here referréd to, it is possible to differentiate the larva from the pupa by reference to the secreted waxy fringes. Still, as a rule, it may, perhaps, be admitted that in this family the typical larva passes nearly imperceptibly into the pupa stage. But I am able in this paper to report some species (*e g.*, *A. floccosa*, *A. piperis*, &c.) in which the larva is clearly distinct from the pupa, and in its metamorphosis discards its envelope, the exuviæ remaining attached to the pupa-case. In these species I am unable to detect any rudimentary organs in the larva.

It is possible that at a future time it may be thought necessary to create a new genus, or perhaps a sub-genus, for the species which thus depart from the usual rule. I report in this paper only four of these; but others may hereafter be found. However, at present I shall not separate them. In only one of the four (*A. piperis*) have I yet seen the adult form, and that does not seem to present any remarkable features.

The pupa-case, as remarked above, in the normal state

may be distinguished from the "late larva" principally by its size. But it happens not unfrequently that there are other characters which may be employed. Colour may be to some extent considered, and in many cases the pupæ can be recognised by their darker tinge. As a rule, also, the rudimentary feet and antennæ are in this stage much more distinctly visible, although sometimes (*e.g.*, *A. barodensis*, *A. limbata*, &c.) the very dark colour prevents this. Again, sometimes the fringes or hairs of the larva are absent from the pupa (*e.g.*, *A. asplenii*, *A. cotesii*), or the arrangement of the hairs or wax may differ (*e.g.*, *A. hirsuta*). On the whole, it is not difficult to decide whether a specimen is a larva or a pupa, though there are exceptions; of course, there can be no doubt in those cases where the larval exuviæ are seen on the dorsum of the pupa.

I may here remark, in passing, that, as far as my experience goes, the *Aleurodidæ* differ from other Homoptera in being always on the under-surface of leaves. *Coccidæ* and *Psyllidæ* are found indiscriminately on leaves or twigs, and often on both upper and lower surfaces of a leaf; but I have never seen an *Aleurodes* except on a leaf, on the lower side—I mean, of course, a larva or a pupa.

It remains to speak of an organ which is quite characteristic of this family, and which, more or less modified, is visible in every stage of growth after the egg. Viewing an Aleurodid larva or pupa with the naked eye, or with a lens of low magnifying-power, it is scarcely possible to distinguish it from a Coccid, especially of the section *Lecaninæ*, especially if, as sometimes happens (*e.g.*, *A. decipiens*), there is a cleft in the abdominal extremity. But on applying a greater magnifying-power it is observed that, whereas in a Lecanid there are two minute subconical lobes visible on the abdominal dorsum, there is seen in an Aleurodid a minute orifice, more or less elliptical or subconical posteriorly, and more or less depressed, or even slightly convex, anteriorly. This orifice is partially closed by a plate which is hinged on the anterior edge of the orifice, but does not extend altogether to the posterior edge. No author known to me has entered into any details regarding this organ; and yet, as it is persistent in one form or another from the earliest larval stage to the latest adult state, and is entirely characteristic of the family, it may be well to elucidate it as far as possible. Signoret merely remarks that in the adult there is on the last abdominal segment "a kind of elongated tubercle of varying shape, apparently allied to the cornicles of *Aphis*"; but he does not say anything about its presence in the earlier stages. I have not found any other author who pays particular attention to this organ except Mr. R. T. Lewis (Journ. of Quekett Micr. Club, 1895), who

mentions it, and gives figures of it on the adult only; and Mr. J. W. Douglas, who, in the *Entomologists' Monthly Magazine*, 1891, figures the organ on the pupa of *A. rubicola*.

I have in this paper noted carefully what seem to be specific variations in this organ, believing it to be quite a valid differentiating character. It consists of three parts. First, an orifice in the dorsal surface of the abdominal region, to which I have given the name of the "vasiform orifice," from its general outline. Secondly, a plate hinged upon the anterior edge of the orifice, which I call the "operculum," and which does not entirely cover the orifice. Thirdly, a more or less slender, subcylindrical, tongue-like tube, which I call the "lingula," and of which the length varies considerably, being sometimes shorter than the operculum (*A. fodiens*), sometimes very much longer (*A. decipiens*). In the adult stage the lingula, as a rule, does not project when at rest, the whole organ then appearing as a simple open tubercle on the abdominal dorsum; but in some species (*e.g.*, *A. asparagi*, and in all probability *A. decipiens*) it protrudes as a conspicuous cylindrical tongue. The lingula also very frequently bears some fine hairs or setæ, varying from extremely minute to considerably long ones.

I strongly incline to the belief that this organ is concerned with the secretion of "honeydew." The *Aleurodidæ* do not seem to produce this substance in such quantities as the *Coccidæ* and the *Aphididæ*, and the leaves which they attack are therefore usually less subject to be covered with black fungus than is the case with those families; but they do produce some. For example, Messrs. Riley and Howard, in *Insect Life*, 1893, p. 316, observe of *A. cocois*, "The upper surface (of a leaf) is frequently attacked by a smut-fungus which is developed on the honeydew thrown down from the under-sides of the leaves above. The honeydew attracts numerous ants." In my paper "On the Honeydew of *Coccidæ* and the Fungus accompanying these Insects" (Trans. N.Z. Inst., 1886, p. 41), I drew special attention to this secretion and to the blackening of the leaves by it, and I described and figured an organ which I had actually seen employed in the production of honeydew in the species *Ctenochiton elæocarpi*. That species belongs to the Coccid section *Lecaninæ*, and in that section, on the abdominal dorsum, there are always present two subtriangular projecting lobes, from between and beneath which the tubular organ just mentioned was protruded whilst I was watching the specimen. I am convinced that the "lingula" of *Aleurodes* is homologous with the honeydew organ of *Ctenochiton*, and that its function is the production of honeydew.

In a letter to me respecting *A. asparagi* Mr. Lewis tells

me that he is informed that "something analogous [to the lingula] is found in certain Coleoptera adjacent to the generative organs, and that they are regarded as of the nature of palpi." But I think that the explanation which has just been given will be nearer the truth.

As regards the waxy secretions of the *Aleurodidæ*, I may say that, in my experience, they never take the form of solid homogeneous plates, as in some *Coccidæ*. Often, when an *Aleurodes* pupa is lifted from a leaf, a ring of wax is left behind, and to the naked eye appears rather solid; but on close examination it is seen to be composed of adjacent tubes. The marginal fringes and dorsal wax of larvæ and pupæ are also not solid. On the other hand, I think they scarcely reach the same degree of fineness and "fluffiness" as the secretion, say, of some *Dactylopidæ* or *Acanthococcidæ*, which seems really like soft cotton. In chemical composition, doubtless, the secretion of an Aleurodid will not differ from that of a Coccid. Amongst the species described in this paper, *A. croceata* has the most solid-looking marginal wax; but even in that close observation will detect a tubular structure. This fact arises from the character of the margin in the larva and pupa. The figures which I give show that the margin is never quite entire, but presents a "crenulated" appearance, more or less conspicuous. The "crenulations" are merely the extremities of cylindrical tubes closely adjacent, each of which has the function of secreting wax, and this wax, therefore, necessarily preserves the form impressed upon it at its origin. It does not necessarily follow that a crenulated margin always carries a fringe; for example, *A. hirsuta* has deep crenulations but no fringe.

A curious illustration of my remark just now, that the *Aleurodidæ* affect only the under surfaces of leaves, and never (or scarcely ever) the upper surfaces, and therein differ from other Homoptera, has been furnished to me since this paper was written. Mr. C. Musson sent me, from the Kurrajong Hills, in New South Wales, some leaves of *Syncarpia laurifolia* which were covered with numbers of very deep pits on the upper surfaces, the other sides being pressed out into conspicuous elevations. Examining these with a lens, I found in each pit what seemed to be an Aleurodid pupa, looking dorsally very much like that of *A. melicyti*. When, however, I extracted one of these, I found that the rudimentary feet and antennæ were not enclosed in the pupa-case, but were very distinctly free and active (the ventral surface of the insect being exceedingly convex); and on examination, under the microscope, no trace appeared of any vasiform orifice. Further, the extremity of each foot was furnished with a fan-shaped pad beneath the two claws. It was clear, therefore, that I

had to do with a Psyllid, and not with an Aleurodid, a fact of which I had originally some suspicion when I saw the insects on the upper instead of the under surface of the leaf. But the very great dorsal similarity, at first sight, to an Aleurodid showed the necessity of much care before arriving at a decision.

A paper on *Aleurodidæ* would be incomplete without some notice of the means available for destroying these injurious insects, or at least minimising their effects. They are very closely allied to the *Coccidæ*, and derive their nourishment from plants in the same way—through their rostral tubes; and a similar mode of combatting them will be available for both families. The most successful plan will therefore be, as for *Coccidæ*, applications of kerosene emulsion in the form of spray. I see no reason why the formula used against Coccids should not be good against Aleurodids. That formula is as follows: Take of common soap, ½lb.; kerosene, 2 gallons; soft water, 1 gallon. First dissolve the soap in the water, heated to boiling, then add the kerosene, and churn the mixture until a creamy fluid results, which thickens on cooling. Dilute with nine or ten (or, for tender plants, twelve to fourteen) times the quantity of water. Apply in the form of the finest possible spray by using one of the different kinds of "cyclone" nozzle, in dry, and preferably cloudy, weather, repeating the dose after about ten days.

The foregoing formula was recommended by me several years ago in my "Scale-Insects of New Zealand," and I have not seen any reason since to change it.

The process just mentioned is intended for the larval and pupal states of *Aleurodidæ*, and will undoubtedly require some care on account of the habit (already noted) of these insects to attach themselves almost, if not quite, exclusively to the under-sides of leaves, where it is, of course, difficult to get at them. In the case of such trees as orange, or tall plants like sugar-cane, the trouble is less than with low-growing plants such as tomato, cabbage, or tobacco. Still, the spray may be made to reach even these satisfactorily.

When the Aleurodids are in their adult stage they may be treated like Aphides on roses or other plants, and tobacco-water, or soapsuds, or the well-known "Gishurst compound" may be used. If not over too large an area, advantage may be taken of their habit of rising on the wing in numbers when the plant is disturbed, and then after a few minutes settling again. While in the air they may be easily caught, sometimes in hundreds, in an ordinary entomological net, and destroyed.

Genus ALEURODES, Latreille.

Insects attacking plants, oviparous; metamorphosis incomplete; fixed in the earlier stages to leaves, free and active in the adult stage, when they usually have a habit of rising in a cloud when disturbed and settling again after a short time.

Adults of both sexes having four wings, which are usually floury, and may be immaculate or spotted or patched. Antennæ of seven joints. Eyes reniform (or more seldom divided), the anterior segment the smallest; two small simple ocelli between the eyes. Mouth-parts consisting of a conical or subconical protruding rostrum, at the end of which are three tubular suctorial setæ, and beneath the rostrum is an elongated subcylindrical free mentum; the mouth and digestive organs are present in both adult sexes. First two joints of the antennæ small and simple; remaining joints long, slender, and numerously ringed; the last joint terminates in two minute spines. Feet long and slender, none of the joints being much thickened; tibia usually about twice as long as the tarsus; tarsus two-jointed, ending with three claws, of which the median is small and spiny. Abdomen in both sexes bearing dorsally on the last segment a more or less tubercular (honeydew) organ composed of an orifice, an operculum, and a lingula; the lingula usually concealed, sometimes projecting. Genitalia terminal; genitalia of female conical, more or less acute, divided into two sections, between which is the ovipositor; genitalia of male forcipate, enclosing the penis. Wings exhibiting in each only a single median vein with one basal posterior branch; the wings are carried flat at rest.

Pupæ enclosed in more or less transparent chitinous cases of elliptical form, convex above, flat beneath. Rudimentary antennæ, feet, and wings enclosed, and in many cases visible through the case. Rostrum and setæ protruded. Pupa-case naked, or bearing hairs or spines, which may carry more or less of dorsal wax or meal; margin composed of adjacent tubes, from the ends of which may be produced a fringe of waxy threads, varying in length and in solidity; this fringe is sometimes replaced by a ring of wax more or less thick and elevated; sometimes the fringe is entirely absent. On the abdominal dorsum is an (honeydew) organ similar to that of the adult, but usually less tubercular; the lingula may protrude or be obsolete.

Larvæ elliptical, usually flat and thin; sometimes enclosed in chitinous cases, which are discarded on changing to the pupal state. Organs in the earliest stage not usually recognisable, but becoming faintly visible with the growth of the insect. Dorsal abdominal organ as in the pupa.

Eggs elliptical, with a short peduncle for attachment to the leaf.

The relationship between Aleurodes and a Coccid of the section *Lecaninæ*, or a Psyllid of the section *Triozinæ*, is very noticeable in the earlier states; and the principal character by which it can be distinguished is the vasiform orifice, which has its counterpart in a Lecanid in the abdominal lobes, and in a Triozid in the "anal ring" (see my paper on *Psyllidæ*, Trans. N.Z. Inst., 1889). Another, but less conspicuous, difference is in the feet: in a Lecanid there is but a single claw, and in a Psyllid the two claws have beneath them a fan-shaped pad. The adult Aleurodes differs from Coccids in the possession of four wings in both sexes, and from Psyllids in the single median vein of both wings.

For a reason of which I am not aware, the word "Aleurodes" has been treated by all authors as feminine. I have not thought it worth while to disturb the arrangement.

1. **Aleurodes abutilonea,** Haldeman. Journ. Amer. Soc. Sci. and Arts, 1850, 2nd ser., p. 108.

2. **Aleurodes aceris,** Geoffroy. *Chermes aceris ovatus*, Geoff., Hist. abr. des Insectes, 1764, p. 509; *Aleurodes aceris*, Bärensprung, Zeit. fur Zool. Alton und Burm., 1849, p. 176; Bouché, Entom. Zeit. Stett., 1851, p. 108; Frauenfeld, Verh. Zool.-Bot.-Gesellsch., Wien, 1866, p. 795; Signoret, Ann. de la Soc. Entom. de France, Dec., 1867, p. 394.

3. **Aleurodes aëpim,** Goldi. Mittheil. Schweitz. Entom.-Gesellsch., vii., 1886, p. 250.

4. **Aleurodes asparagi,** Lewis. Journ. Quek. Micr. Club, 1895, p. 88; Rep. Ealing Soc., 1893, p. 1.

5. **Aleurodes asplenii,** Maskell. Trans. N.Z. Inst., 1890, vol. xxii., p. 173.

Vasiform orifice subconical; operculum small; lingula moderate, clavate.

6. **Aleurodes avellanæ,** Signoret. Ann. de la Soc. Entom. de France, Dec., 1867, p. 385; Douglas, Ent. Mo. Mag., 1894, vol. xxx., p. 154.

7. **Aleurodes banksiæ,** Maskell, sp. nov. Plate XXV.—1.

Larva brown, elliptical; length about $\frac{1}{75}$in. Margin distinctly crenulated, but bearing no fringe. Abdominal segments fairly distinct. Dorsum bearing, within the margin, a row of longish, strong spines, of which four, on the anterior region, extend beyond the margin; also, on the anterior

thoracic region, six other spines in two rows; the extremities of all these spines are dilated into three minute spicules. Vasiform orifice with regularly convex sides and end, the anterior edge concave; operculum moderate, subcircular; lingula obsolete.

Pupa-case intense glossy black, flattish, elliptical; length about $\frac{1}{25}$in. Abdominal segments moderately distinct. Margin crenulated, but less conspicuously than in the larva; there is sometimes a small fragmentary waxy fringe. Dorsum bearing rows of short fine hairs in place of the strong spines of the larva.

Adult form unknown.

*Hab.* In Australia, on *Banksia integrifolia* and on *Callistemon linearis*. My specimens were sent from Melbourne by Mr. C. French.

8. **Aleurodes barodensis,** Maskell, sp. nov. Plate XXV.—2.

Eggs orange-coloured, rather large, oval, pedunculated; length about $\frac{1}{180}$in. The eggs and empty shells are found in large numbers on the leaf.

Larva dark-brown, becoming later almost black; elongated elliptical; slightly convex; abdominal segments fairly distinct; length about $\frac{1}{48}$in. Margin minutely crenulated, and bearing a short white waxy fringe, which is frequently very fragmentary or absent. Dorsum bearing, within the margin, a row of about thirty-two small simple circular pores; within these is a transverse row of four on the anterior thoracic region, another transverse row of four on the anterior abdominal region, a longitudinal row of four on each side of the abdomen, and one on each side of the vasiform orifice. Vasiform orifice subconical, the posterior extremity slightly produced; operculum short, rounded, subconical; lingula cylindrical at the base, afterwards widened, finally tapering, not quite reaching the edge of the orifice.

Pupa-case very dark-brown or glossy-black; very elongated, elliptical, with sides nearly straight, the width only about one-third of the length. Dorsum sometimes slightly convex, sometimes flat, sometimes slightly concave; abdominal segments indistinct. Vasiform orifice apparently as in the larva, but difficult to make out on account of the very dark colour of the case. Margin crenulated, and bearing a very elegant, long, snowy-white fringe of slender waxy cylindrical tubes. There is frequently some white powdery meal on the dorsum, which probably bears pores as in the larva, but it is most difficult to detect them. The ventral surface is flat, brown; the rudimentary organs are not distinct, owing to the dark colour.

Adult form unknown.

*Hab.* In India, on *Saccharum officinale.* My specimens were sent by Mr. Cotes, late of the Indian Museum, Calcutta, from Baroda. He informed me they were rather damaging to the sugar-cane in those parts.

The very elongated form is distinctive, besides the black colour.

9. **Aleurodes bergii,** Signoret. Ann. de la Soc. Entom. de France, Dec., 1867, p. 395.

10. **Aleurodes brassicæ,** Walker. Catal. of Homopt. in Brit. Mus., p. 1092; Koch, Pflanzenläuse, p. 326; Frauenfeld, Verh. Zool.-Bot.-Gesellsch, Wien, 1867, p. 794; Douglas, Ent. Mo. Mag., 1895, vol. xxxi., pp. 68, 97.

11. **Aleurodes capreæ,** Signoret. Ann. de la Soc. Entom. de France, Dec., 1867, p. 384.

12. **Aleurodes carpini,** Koch. Die Pflanzenläuse, Aphiden, 1857, p. 395; Signoret, Ann. de la Soc. Entom. de France, Dec., 1867, p. 382; Douglas, Ent. Mo. Mag., 1895, vol. xxxi., p. 117.

13. **Aleurodes cerata,** Maskell, sp. nov. Plate XXVI.—1.

Larva yellow, flattish, elliptical, with a slight constriction near the postërior extremity; length about $\frac{1}{27}$in. Dorsum hairless, but there are some scattered, extremely minute simple circular pores which produce a small quantity of white meal, and this sometimes rises into small lumps of felted threads. Margin thickened, formed of closely adjacent cylindrical tubes, the ends of which form minute crenulations, from which springs a fringe of moderately long white wax. Vasiform orifice subconical, with concave anterior edge and emarginate sides; operculum regularly subelliptical; lingula not quite reaching the end of the orifice.

Pupa-case orange-yellow; outline as in the larva, but rather more convex; length about $\frac{1}{20}$in. Dorsum hairless, but bearing many small simple circular pores, not set closely together: from these pores is produced a quantity of white wax much more plentiful and solid than in the larva; sometimes it forms only a thick, nearly homogeneous shell covering the insect; in other cases it is produced in several curling and irregular more or less cylindrical processes; in others again several pupæ are covered by one agglomerated mass. Margin as in the larva, and bearing a similar white fringe, amongst the tubes of which are some slender threads longer than the fringe. On turning over the pupa-case the rudimentary organs are clearly visible.

Adult form unknown.

*Hab.* In New Zealand, on *Fagus menziesii*. My specimens were sent by Mr. Raithby, from Reefton.

This handsome form may be easily mistaken for a Coccid. It is typical of the family in this respect: that the pupa is distinguishable from the larva principally by size and the larger quantity of waxy matter.

14. **Aleurodes citri**, Riley and Howard (Ashmead). *Insect Life*, 1893, p. 219.

15. **Aleurodes comata**, Maskell, sp. nov. Plate XXVI.—2.

Eggs yellowish-brown, elliptical; length about $\frac{1}{180}$in.; peduncle rather short.

Larva yellow; somewhat thick, flattish, regularly elliptical; length about $\frac{1}{35}$in. Dorsum bearing four longish fine hairs, of which two are on the cephalic region and two close to the vasiform orifice. Margin entire, not thickened, bearing a row of rather long, strong hairs, sixteen on each side, and two shorter ones at the abdominal extremity. Rudimentary eyes dark-red, tubercular, may be made out. Vasiform orifice broad, short, subelliptical; operculum short, transversely divided; lingula obsolete.

Pupa-case yellow; elliptical; length about $\frac{1}{25}$in. The dorsal four hairs as in the larva, and there is usually a small quantity of dorsal white meal. Abdominal segments indistinct. Margin with wide, shallow crenulations; marginal hairs as in the larva. Vasiform orifice, operculum, and lingula as in the larva. On turning over the pupa-case the rudimentary feet, antennæ, &c., are clearly visible.

Adult of general normal form; length of body about $\frac{1}{30}$in. Head and thorax dark-yellow. Abdomen lighter yellow. Genitalia brown. Wings narrow, grey; nervure straight; the basal branch very short, almost obsolete; margins of wings minutely serratulate, each serration bearing a minute spine; on the anterior edge of the hind-wing are four very fine hairs. The fore-wing bears four faint brownish patches difficult to distinguish; they form almost two transverse bands, but do not seem to meet at the nervure. Genitalia of male and female normal; each arm of the forceps of the male bears a few short hairs.

*Hab.* In Fiji, on a gramineous plant unknown to me. My specimens were sent by Mr. R. L. Holmes.

This species may be distinguished by the marginal and dorsal hairs of the larva and pupa. Something similar may be seen in *A. citri*, Riley and Howard, as figured in *Insect Life*, 1893, p. 219; but that species has four cephalic and four posterior long dorsal hairs; its wings are immaculate, and the adult male bears remarkable tufts of wax on the

abdomen; the serrations of the wing-margins are also different.

16. **Aleurodes corni**, Haldeman. Journ. Amer. Soc. Sci. and Arts, 1850, p. 108; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 398.

17. **Aleurodes cotesii**, Maskell, sp. nov. Plate XXVII.—1.

Larva yellow, the median region darker than the margin; form elliptical; length about $\frac{1}{70}$in. In the earliest state only very faint indications of the insect itself appear, and the whole is very thin and flat; later on the enclosed future pupa begins to be visible, and the ventral surface becomes more convex; the eyes also appear. The larval integument becomes too small for the growing insect, and splits longitudinally; and in the early pupal state it may be seen attached along the dorsal edges of the pupa-case. Margins somewhat thickened, the adjacent tubes forming minute crenulations, and within it the dorsum bears numbers of very small circular pores; from these and from the marginal tubes is produced a quantity of white waxy matter, some of which covers the dorsum in scattered patches, and the rest spreads out round the larva in a very long fringe of delicate threads, frequently much longer than the insect itself. This waxy matter is very brittle, and, as a rule, the whole surface of a leaf is powdered over with the fragments, making the leaf look as if mildewed.

Pupa-case, in the earliest state, scarcely distinguishable from the late larva; afterwards, as the insect grows, it becomes much thicker. The form remains elliptical; the length reaches about $\frac{1}{50}$in. The dorsal disk is slightly convex, flattened towards the margin; it is larger than the ventral disk, and slightly overlaps the sides, which are vertical. The hollow thus formed is covered by a ring of thin white wax, and there is also a plate of wax beneath the ventral surface; portions of this ring and of the plate are frequently seen amongst the long threads of the larva. The pupal margin is crenulated, but bears no fringe, and the dorsum has no pores or wax. The outline of the enclosed pupa may be made out indistinctly on the dorsum, and the rudimentary organs ventrally on turning over the case. Vasiform orifice subconical, with regularly convex sides, the anterior edge concave; operculum subelliptical; lingula very short, not extending beyond the operculum.

Adult form unknown.

*Hab.* In India, on *Rosa*. My specimens were sent by Mr. Cotes, late of the Indian Museum, Calcutta. They came from Quetta, Beluchistan. I have named the species after him.

The overlapping of the sides by the dorsal disk of *A. cotesii*

is found also in a New Zealand species, *A. fagi*, Maskell, 1889; but that insect has no fringe, and the margin bears twenty-four hairs.

18. **Aleurodes croceata,** Maskell, sp. nov. Plate XXVII.—2.

Larva light-brown, thin, flattish, elliptical; length about $\frac{1}{30}$in. Dorsum bearing two spines on a level with the rostrum, but no others, nor any hairs. Margin deeply crenulated, truncate at the posterior extremity, where there are two rather long setæ. Fringe absent, or very fragmentary.

Pupa-case dull-black, elliptical; dorsum convex; length about $\frac{1}{24}$in.; abdominal segments fairly distinct. Dorsum apparently without hairs or spines. Margins deeply crenulated, and surrounded by a mass of yellow wax, which is composed of slender tubes so closely adjacent as to be almost homogeneous; this fringe is not flat, but has the internal edge elevated, so that the pupa-case looks raised up on a sloping yellow ring. Vasiform orifice small, subconical, with a very convex anterior edge; operculum nearly covering the orifice; lingula short, subcylindrical.

Adult form unknown.

*Hab.* In Australia, on *Styphelia (Monotoca) elliptica.* My specimens were sent by Mr. Froggatt, from Botany, near Sydney.

The sloping yellow waxy ring will readily distinguish this species in the pupal state. This ring is so nearly homogeneous that it looks quite glassy and solid.

19. **Aleurodes decipiens,** Maskell, sp. nov. Plate XXVIII.—1.

Larva yellow, with often a pinkish tinge; elongated elliptical, the width about two-fifths of the length; dorsum slightly convex; length about $\frac{1}{18}$in. Faint indications of the future pupa may be discerned. Dorsum hairless, but covered with great numbers of rather conspicuous though not much elevated pustules, which are larger towards the margin than on the median region. Margin slightly thickened, composed of adjacent tubes whose ends form crenulations, from which spring short curling cylinders of wax usually not set closely together. Abdomen distinctly cleft from the vasiform orifice to the posterior margin, where there is a short seta on each side of the cleft. Vasiform orifice conical, very much elongated, the anterior edge concave, sides emarginate, nearly one-half the length of the cleft; operculum subcircular; lingula excessively long, but not extending beyond the orifice, cylindrical at the base, then somewhat dilated, then tapering to a point where there are two rather long setæ; the dilated portion of the lingula is covered with very minute dots, which may perhaps be fine hairs.

Pupa-case not observed with certainty, but amongst several larvæ on the leaves sent there is one pupa which may possibly belong to this species. It is yellow, elliptical, flattish; length about $\frac{1}{25}$in.; margin and marginal cylinders as in the larva. Dorsum covered with great numbers of pustules, smaller and less conspicuous than those of the larva, and bearing also six short spiny hairs, one on each side of the rostral region, one on each side of the thoracic region, and one on each side of the vasiform orifice; also eight transverse rows of minute circular pores on the cephalic and thoracic regions. The abdomen is distinctly cleft, and there are two short setæ at the posterior extremity. But the vasiform orifice differs from that described above: it is subcircular, with a concave anterior edge; operculum rhomboidal; lingula very short, not extending beyond the operculum. The rudimentary antennæ and feet may be made out with moderate clearness.

Adult form unknown.

*Hab.* In Australia, on *Styphelia (Monotoca) elliptica.* My specimens were sent by Mr. Froggatt, from Botany, near Sydney, in company with *A. croceata.*

The principal feature of the larva of this species is its remarkable resemblance to a Coccid of the section *Lecaninæ.* At first sight the abdominal cleft seems to point directly to a Lecanium, and the characters of the dorsum and the margin might also be Lecanid; but an examination of the very peculiar vasiform orifice and its lingula shows that it is clearly Aleurodid. I have thought it well to indicate by the specific name the deceptive nature of the general appearance. If the pupa above described belongs to *A. decipiens*, it will be exceptional from being smaller than the larva; as for the differences in the dorsal hairs and vasiform orifice, they may be unimportant.

20. **Aleurodes dubia,** Hegeer. Beitrag zur Naturges. der Ins., 1859, p. 14; Signoret, Ann. de la Soc. Entom. de France, Dec., 1867, p. 392.

21. **Aleurodes erigerontis,** Maskell, sp. nov. Plate XXVIII.—2.

Larva not observed.

Pupa-case pale-yellow, flattish, elliptical; length about $\frac{1}{25}$in. Abdominal segments moderately distinct. The enclosed pupa is brownish, and faintly discernible dorsally; on turning over the case the rudimentary feet and antennæ may be made out, but confusedly. Margin composed of slender tubes, giving it a fluted appearance, their ends forming minute crenulations; it bears a short fringe of white, straight cylinders of wax, which is frequently very fragmentary. Dorsum hairless, but exhibiting within the margin a row all round of

small tubercular papillæ, set rather closely together; from these spring moderately long, curling, white waxy cylinders, which are extremely brittle, and therefore frequently broken off. Within this series the dorsum has eight large circular orifices, two on the cephalic, four on the thoracic, and two on the abdominal regions. Vasiform orifice elongated, conical, with emarginate sides, and a deeply bifid apex; operculum elongated, conical, with emarginate sides, and end rounded; lingula moderate, extending a little beyond the operculum, its outer end clavate and emarginate. Eyes red, reniform; after treatment with reagents they appear fluted at the base.

Adult form unknown.

*Hab.* In Mexico, on *Erigeron* sp. My specimens were sent by Mr. T. D. A. Cockerell.

This species is closely allied to *A. nicotianæ*, described below; but differs in the number and arrangement of the large dorsal orifices, in the vasiform orifice, and in the absence of lateral depressions.

22. **Aleurodes eugeniæ**, Maskell, sp. nov. Plate XXIX.—1.

Larva dull-white or grey, or slightly yellowish; form roundly elliptical, the anterior edge very slightly compressed; dorsum scarcely convex; length about $\frac{1}{40}$ in. Dorsum marked with very delicate radiating striæ. Margin without either fringe or hairs, and not at all thickened, but finely fluted and minutely crenulated. Three marginal depressions and radiating dorsal patches as described below in the pupa.

Pupa-case very pale yellow, or greyish; dorsum very slightly convex; form roundly elliptical or subcircular; length about $\frac{1}{20}$ in. as a rule, but reaching $\frac{1}{18}$ in. The enclosed pupa is conspicuous dorsally, dark-brown, the segments fairly distinct; on turning over the case the rudimentary feet may be made out rather confusedly, and the antennæ more faintly. Dorsum of the case marked with radiating striæ, more clear than those of the larva: these striæ are most conspicuous near the margin, which is not at all thickened, nearly entire, but marked with narrow but deep channels dividing it into broad segments. At three points in the margin there are small concave depressions, one at each side opposite the rostrum, and one at the abdominal extremity. Corresponding with these, on the dorsum, are three very faint radiating dotted patches: when viewed by transmitted light, these patches are seen to be formed of a lace-like pattern, with small irregular cells, and at their extremity they end in a circular orifice deeply crenulated; the anterior pair extend from the rostrum to the margin, the posterior one from the vasiform orifice to the margin. Vasiform orifice with straight anterior edge, sides and end regularly convex; operculum

nearly covering the orifice, and of similar form; lingula short, almost regularly cylindrical, scarcely extending beyond the operculum. There is no marginal fringe, nor are there any dorsal or marginal hairs.

Adult form unknown.

*Hab.* In India, on *Eugenia jambolana*. My specimens were sent by Dr. Alcock, Superintendent of the Indian Museum, Calcutta. From the great numbers on the leaves it would seem that the insect is injurious. They came from Poona.

A short description of this insect was sent by me to Dr. Alcock for insertion in "Indian Museum Notes"; but I have included it again here in order to note the distinctions which separate it, firstly from *A. eugeniæ*, var. *aurantii*, next described, and secondly from *A. citri* (Ashmead), Riley and Howard, *Insect Life*, 1893, p. 219. As to the first, my descriptions and figures will suffice. From *A. citri* the species differs in the entire absence of marginal and dorsal hairs in the larva and in the three radiating lace-work patches, of which no mention is made by Riley and Howard, but which are conspicuous characters of *A. eugeniæ*.

This insect and its variety, with *A. citri*, *A. melicyti*, and others, may be placed in a series of which *A. proletella*, Linn., may be taken as the type.

23. **Aleurodes eugeniæ**, Maskell, var. *aurantii*, var. nov Plate XXIX.—2.

Larva very pale-yellow, sometimes almost white; form roundly elliptical, flattish; length about $\frac{1}{40}$in. Dorsum striated, but the striations are very faint, except near the margin. Margin not at all thickened, finely fluted and crenulated, bearing no hairs or fringe. There are three small marginal depressions and three dorsal patches, as in the pupa.

Pupa-case very pale-yellow, roundly elliptical or subcircular, flattish and thin; length about $\frac{1}{24}$in., reaching sometimes as much as $\frac{1}{16}$in. The enclosed pupa is only faintly discernible dorsally, rather darker than the case, the abdominal segments moderately distinct; on turning over the case the rudimentary organs are less confused than in *A. eugeniæ*. Dorsum of the case very finely marked with radiating striæ, which are a little more conspicuous near the margin. Margin not thickened, almost entire, divided by deep narrow channels into segments narrower than those of *A. eugeniæ*. There are three marginal depressions, two opposite the rostrum and one at the abdominal extremity, and three radiating patches terminating at these depressions; the patches end (as in the type) in crenulated circular orifices, but are composed of great numbers of very minute circular pores or dots, which do not form a lace-work pattern. Vasiform orifice subtrapezoidal or

subelliptical, broader than long; operculum nearly fitting the orifice; lingula very short, cylindrical with a dilated end, sometimes obsolete.

Adult form unknown.

*Hab.* In India, on *Citrus aurantium.* Mr. Cotes, late of the Indian Museum, Calcutta, sent me some orange-leaves from "North-west Himalayas," thickly covered with this insect.

I attach this as a variety to *A. eugeniæ* on account of the similarity in several respects, notably in the dorsal radiating patches, though it differs in some others. It has none of the marginal or dorsal characters of *A. citri*, Riley and Howard.

24. **Aleurodes fagi,** Maskell. Trans. N.Z. Inst., 1889, vol. xxii., p. 175.

25. **Aleurodes filicum,** Goldi. Mittheil. Schweitz. Entom. Gesellsch., 1886, p. 247; Douglas, Ent. Mo. Mag., 1891, p. 44.

26. **Aleurodes floccosa,** Maskell, sp. nov., Plate XXX.—1.

Larvæ and pupæ covered, either singly or in colonies, with more or less of white flocculent matter.

Larva dull-yellow, elongated elliptical; dorsum very slightly convex; length about $\frac{1}{68}$in. The tubes of the margin end in very minute crenulations, and bear a white, almost always very fragmentary, waxy fringe. The dorsum bears eight strong spines in pairs; the three pairs on the cephalic, thoracic, and anterior abdominal regions are rather broadly lanceolate; the pair close to the vasiform orifice are cylindrical. The larval exuviæ are found, as described below, attached to the pupa-case.

Pupa-case dull-yellow, elliptical; dorsum slightly convex; the enclosed pupa brownish, moderately distinct; length about $\frac{1}{48}$in. to $\frac{1}{30}$in.; the median region over the pupa is more convex than the margins. Margin composed of adjacent tubes forming conspicuous crenulations, which bear, besides the flocculent matter, a moderately long fringe of straight white waxy tubes. Dorsum bearing six long slender spines in pairs; one pair is on the thoracic region, another pair close to the vasiform orifice, and a third pair near the abdominal extremity; this last pair frequently bear a pencil of white wax (as shown in my figure). These spines are not lanceolate but cylindrical, with tubercular bases. The larval exuviæ seem to be attached to the pupal dorsum by the two thoracic long spines, and as the larval and pupal colours are the same it is easy to mistake the lanceolate larval spines as belonging to the pupa.

Vasiform orifice twice as broad as long, anterior edge concave, posterior edge nearly straight, sides rounded; operculum short, broad, subelliptical; lingula obsolete.

Adult form unknown.

*Hab.* In Jamaica, on *Lignum vitæ*, in company with *A. stellata* (described below), which is frequently seen entangled in the flocculent mass of *A. floccosa*. My specimens were sent by Mr. Cockerell.

The dorsal spines (differing in the larva and the pupa) will distinguish this species. Perhaps, when the adult is known, the insect may be found to be an *Aleurodicus*, in which genus *A. anonæ*, Morgan, and *A. cocois*, Curtis (also West Indian species), produce masses of flocculent matter. Clearly, however, the organs which I have described separate *A. floccosa* from these two; and I find no mention anywhere of the carrying in them of the larval exuviæ on the pupal dorsum, surely an important character.

27. **Aleurodes fodiens**, Maskell, sp. nov. Plate XXX.—2.

Larva dull-yellow, flat, elliptical; length about $\frac{1}{50}$in. Dorsum faintly striated transversely. Margin very minutely crenulated, and bearing no fringe or hairs.

Pupa-case dull-yellow, flat, almost circular; diameter about $\frac{1}{27}$in. Enclosed pupa clearly discernible, of a darker colour than the case; abdominal segments distinct. The case is marked with radiating striæ, but there are no tubercles, hairs, or pores, nor any radiating patches. Margin slightly thickened, almost entire; no marginal hairs or fringe. Vasiform orifice subconical, anterior edge slightly concave, sides rounded, apex a little produced; operculum subtrapezoidal, covering about half the orifice; lingula very short, not extending beyond the operculum, frequently obsolete. On turning over the case the rudimentary feet and antennæ are clearly visible: in a late stage the eyes also become very distinct. The pupæ excavate rather deep pits in the surface of the leaf, on the under-side, just large enough to hold the case; on the upper side of the leaf there is a corresponding elevation.

Adult form unknown.

*Hab.* In New Zealand, on *Drimys axillaris*. My specimens were sent by Mr. R. Raithby, from Reefton.

The formation of pits in the leaf is characteristic of this species. In this proceeding it resembles the Coccid insect, *Rhizococcus fossor*, Maskell, 1883, which acts in a similar manner on *Santalum cunninghamii*; and the Aleurodes may very easily be mistaken at first sight for a Coccid. I have no idea of the manner in which this excavation is performed, or of the organs which may be employed in it. I have remarked on this point frequently in my papers on *Coccidæ* when refer-

ring to several species of that family which burrow more or less deeply into leaves or twigs.

28. **Aleurodes fragariæ,** Walker. List of Homopt. in Brit Mus., 1851, 1092; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 383.

29. **Aleurodes fraxini,** Signoret. Ann. de la Soc. Ent. de France, 1867, p. 386.

30. **Aleurodes goyabæ,** Goldi. Mittheil. Schweitz. Entom. Gesellsch., 1886, vii., p. 248.

31. **Aleurodes hirsuta,** Maskell, sp. nov. Plate XXXI.—1.

Larva pale-yellow, very thin and flat, elliptical; length about $\frac{1}{48}$in. Dorsum bearing about twenty-eight rather long slender spines, which may be considered as arranged in two series, one submarginal, the other median; the extremities of these spines are dilated, and bear three very minute spicules. Margin distinctly crenulated, but the tubes are very indistinct; there is no fringe; there are three small marginal depressions, one on each side opposite the rostrum, and one at the abdominal extremity.

Pupa-case pale-yellow; elliptical, the cephalic region somewhat acuminate; length about $\frac{1}{30}$in. The marginal region is flat and thin, the portion covering the pupa considerably convex; the enclosed pupa is clearly visible. The margin is as in the larva, with three depressions; there is no fringe. The dorsum bears, just within the margin, a series of very long slender cylindrical spines, forty-eight in all; there is a second series of about sixteen (eight on each side) following the base of the median convexity; and a third of six or eight on the median region; the ends of most of these spines are dilated as in the larva. Vasiform orifice roundly subconical, with slightly concave anterior edge; operculum similar, nearly covering the orifice; lingula apparently obsolete. Rudimentary feet and antennæ indistinct.

Adult form unknown.

*Hab.* In Australia, on *Acacia longifolia.* Specimens sent by Mr. Froggatt, from Sydney.

This species seems to approach *A. phillyrea,* Haliday (Entom. Mag., 1835, p. 119), but differs in the absence of a waxy fringe, and in the arrangement and the length of the dorsal spines. Signoret (Ann. de la Soc. Ent. de France, Dec., 1867, p. 389) says of *A. phillyrea* that the "tubes of the fringe are so conspicuous as to make it difficult to see the spines, and it is only with a good light that these can be made out." This is certainly not the case with *A. hirsuta.*

32. **Aleurodes holmesii**, Maskell, sp. nov. Plate XXXI.—2.

Larva dull-yellow, elliptical, flattish; length about $\frac{1}{50}$in. Margin thickened, almost entire, the crenulations being very minute and confused. Dorsum bearing, on the thoracic region, six strong rather short spines; of these, two are median, the four others submarginal. In the earliest state there is no fringe, but in the latest stage there is a fragmentary short fringe of white wax.

Pupa-case dull-yellow, rather lighter coloured than the larva; form elliptical, flattish, and rather thick; length about $\frac{1}{25}$in. Abdominal segments moderately distinct. Dorsum bearing a submarginal series of strong short spines; two of these on the cephalic region and four on the posterior abdominal region are large and conspicuous, the other eight (four on each side), on the thoracic region, are smaller. From these spines is produced a quantity of white waxy secretion, which is very fragmentary, often entirely absent; it scarcely ever seems to completely cover the dorsum. Margin very distinctly and conspicuously crenulated with large thick segments; these produce a fringe of closely-adjacent waxy tubes, which at first is flat, then becomes a rather thick ring or cushion, and at last becomes so thick as to raise the pupa somewhat high above the leaf, and then it seems as if resting on a very elegantly-fluted white wall; vasiform orifice subelliptical, with concave anterior edge and broadly-rounded sides and end; operculum broad and short, the posterior edge concave; lingula very long, extended beyond the orifice, subcylindrical, with emarginate sides and compressed extremity, the end rugose, with four rather long and many very short setæ or hairs.

Adult form unknown.

*Hab.* In Fiji, on *Psidium* sp. My specimens were sent by Mr. R. L. Holmes.

The arrangement of the dorsal spines, and the peculiar lingula, will distinguish this species.

33. **Aleurodes immaculata**, Hegeer. Beitrag zur Naturges. der Insekt., 1855, p. 3; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 390; Douglas, Ent. Mo. Mag., 1884, p. 215.

34. **Aleurodes jelinekii**, Frauenfeld. Verh. der Zool.-Bot. Gesellsch., Wien, 1867, p. 799; Signoret, Ann. de la Soc. Entom. de France, Dec., 1867, p. 393.

35. **Aleurodes lacerdæ**, Signoret. Ann. de la Soc. Entom. de France, 1883, p. 63.

36. **Aleurodes lauri**, Signoret. Ann. de la Soc. Entom. de France, 1883, p. 68.

37. **Aleurodes limbata,** Maskell, sp. nov. Plate XXXII.—1.

Larva dark-brown, flat, elliptical; length about $\frac{1}{70}$in. Dorsum hairless. Margin crenulated, but without fringe.

Pupa-case very dark-brown, or intense black, with the marginal region lighter coloured; form elliptical; dorsum convex; abdominal segments indistinct; length about $\frac{1}{16}$in. There appear to be no dorsal hairs, but there are two spines, rather long, on the thoracic region. Marginal tubes ending in large and conspicuous crenulations, from which springs a very long fringe of white wax; the portion of the fringe nearest the case is reticulated, or lace-like; the outer portion extended in long, slender, separate, wavy threads. Vasiform orifice elongated, subconical, with nearly straight anterior edge; operculum about two-thirds as large; lingula not certainly observed, but probably very short, if not obsolete. The larval exuviæ are commonly attached to the pupa-case by the two long dorsal spines.

Adult form unknown.

*Hab.* In Australia. Specimens were sent by Mr. Froggatt on *Acacia longifolia,* from Sydney; and by Mr. C. Musson, on *Leucopogon juniperinus,* from Kurrajong Heights.

The lace-like arrangement of the fringe and the attachment of the larval exuviæ to the pupa-case may be used together to distinguish this species.

38. **Aleurodes loniceræ,** Walker. Catal. of Homopt. in Brit. Mus., 1851, p. 1092; Koch, Pflanzenläuse, 1857, p. 327; Frauenfeld, Verh. der Zool.-Bot. Gesellsch., Wien, 1867, p. 796; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p 381; Douglas, Ent. Mo. Mag., Feb., 1896, p. 31.

39. **Aleurodes melicyti,** Maskell. Trans. N.Z. Inst., 1889, vol. xxii., p. 174.

Vasiform orifice elongate, subconical, anterior edge slightly concave; operculum subsemicircular, small; lingula extending a little beyond the operculum, subcylindrical, the median part compressed, then rather dilated.

The orifice and lingula approach those of *A. rubicola,* Douglas (Ent. Mo. Mag., 1891, p. 322, fig. 5), but the pupa differs considerably in many particulars.

40. **Aleurodes nicotianæ,** Maskell, sp. nov. Plate XXXII.—2.

Larva pale-yellow, very thin, flat, subelliptical, with a depression on each side on the thoracic region, the abdomen tapering to the posterior extremity, where there are two rather long setæ; length about $\frac{1}{30}$in. Dorsum hairless. Margin not thickened, minutely crenulated; there is no fringe, but a few scattered very fine marginal hairs.

Pupa-case yellow, the median region darkening as the pupa approaches its metamorphosis; form elliptical, with four lateral depressions, two on each side (similar to those in the Coccid genus *Lecanium*); length about $\frac{1}{24}$in. Dorsum hairless, but bearing, just within the margin, a series of rather large tubercular pustules, subconical with an apical orifice, set somewhat closely together; and from each of these springs a curling, white, cylindrical waxy tube extending beyond the margin: within this series are twelve other pustules—one, large, on each side of the cephalic region; one, large, on each side of the thoracic region; two, large, on each side of the anterior abdominal region; one, large, on each side close to the posterior extremity; and one, small, on each side of the vasiform orifice. From these last series of dorsal pustules exudes a thin, yellow, waxy matter, which seems to be very brittle, as it is generally only fragmentary. Margin slightly thickened, composed of slender closely-adjacent tubes; there is only a very short fragmentary waxy fringe, although, as the dorsal waxy tubes extend beyond the margin, the case seems at first sight to be fringed; at the posterior extremity there are two setæ. Vasiform orifice sub-semi-elliptical, the anterior edge straight; operculum similar, but about half the size; lingula extending a little beyond the operculum, the extremity clavate, with two grooves.

Adult form unknown.

*Hab.* In Mexico, on *Nicotiana tabacum.* My specimens were sent by Mr. Cockerell, from Guanajuato. I am not sure whether the occurrence of an insect of the order Homoptera on tobacco is exceptional or not. Some time ago I remember an instance of tobacco in the Customhouse at Wellington being found to be infested by a species of weevil which did much damage to the article; but the living plant, as far as I know, is usually free from pests.

This species is nearly allied to *A. erigerontis* (*ante*), but differs in the vasiform orifice, in the arrangement of the dorsal pustules, and in the lateral depressions.

41. **Aleurodes niger,** Maskell, sp. nov. Plate XXXIII.—1.

**Larva not observed.**

Pupa-case at first flattish, but later very convex; form regularly elliptical; length about $\frac{1}{16}$in.; colour very dense dull-black. Dorsum minutely striated; abdominal segments fairly distinct; there are no dorsal hairs or spines. Margins very indistinctly crenulated, the crenulations very wide and shallow; there is no fringe. Vasiform orifice small, semi-elliptical; operculum covering about half the orifice; lingula not observed with certainty, probably obsolete.

Adult form unknown.

*Hab.* In Australia, on *Acacia pycnantha.* My specimens were sent by Mr. French, from Melbourne.

It is possible that this may be only a larger form of *A. banksiæ* (*ante*), but the colour is much less glossy, and the margin differs slightly.

42. **Aleurodes papillifer,** Maskell. Trans. N.Z. Inst., 1889, vol. xxii., p. 173.

Vasiform orifice semi-elliptical; operculum small; lingula broadly clavate.

43. **Aleurodes phalænoides,** Blanchard. Insect. Voy. du Chili, de Gay, 1840, p. 319; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 399.

44. **Aleurodes phillyrea,** Haliday. Entom. Magaz., 1835, p. 119; Bouché, Entom. Zeit. Stett., 1851, p. 108; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 388.

45. **Aleurodes piperis,** Maskell, sp. nov. Plate XXXIII.—2.

Eggs dark-yellow, elongate-elliptical, transversely striated; length about $\frac{1}{125}$in.

Larva very dark-brown or black, very slightly convex, elliptical; length about $\frac{1}{40}$in. Dorsum bearing long, very black spines, of which four are on the cephalic, eight on the thoracic, and ten on the abdominal regions. Margin not thickened, but very distinctly crenulated. There seems to be no fringe.

Pupa-case intense glossy black, slightly convex, with a median longitudinal ridge; abdominal segments indistinct. Form elliptical; length about $\frac{1}{25}$in. Dorsum bearing many long black spines, of which one series of from twenty to twenty-four are submarginal, the others scattered (seemingly about twenty, but very difficult to make out on account of the intense black colour); two of the spines, at the posterior extremity, are longer than the others. Margin with very small crenulations; there is a very short fringe of white wax, which in many specimens is not noticeable. Vasiform orifice broadly rhomboidal with rounded angles, anterior edge slightly concave; operculum semi-elliptical, covering about half the orifice; lingula short, roundly clavate. The larval exuviæ are commonly seen attached by the dorsal spines to the pupa-case.

The pupa extracted from its case is reddish-yellow, the rudimentary feet and antennæ yellow, the rudimentary wings yellow with bands of dark-brown, the eyes dark-brown.

Adult form with the thorax red, banded with brown; the abdomen red; genitalia brown; feet and antennæ darkish-

yellow, tipped with brown. The antennæ and feet are normal. Forewings with three bands of dark-brown, of which the outer one does not quite reach the margin at the extremity. The genitalia do not exhibit any special features.

*Hab.* In Ceylon, on *Piper* (*nigrum* ?). My specimens were sent by Mr. E. E. Green, from Punduloya.

I know of no described species in which the larva and pupa have such strong black spines as this. The wings of the adult are not particularly distinctive, for those of *A. sacchari*. Mask., 1889, have quite similar bands. I have found it extremely difficult to correctly distinguish the dorsal spines on the pupa; and the vasiform orifice also presents much difficulty.

46. **Aleurodes prenanthis,** Schrank. Fauna Boica, 1801, ii., 147; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 399.

47. **Aleurodes proletella,** Linnæus; *A. chelidonii*, Latreille. Linn. Syst. Nat., p. —; Latreille, Mag. Encycl., ii., p. 304; Réaumur, Mém., vii.; Westwood, Introd. to Mod. Class. of Ins., vol. ii., p. 443; Koch, Pflanzenläuse, 1857; Frauenfeld, Verh. der Zool.-Bot. Gesellsch., Wien, 1867; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 378; Douglas, Ent. Mo. Mag., 1894, p. 40; *ib.*, 1895, p. 68.

48. **Aleurodes pulvinata,** Maskell, sp. nov. Plate XXXIV.—1.

Larva not observed.

Pupa-case dark-orange, with two broad lateral longitudinal bands of dark-brown, which do not touch the margin, and which denote the enclosed insect. Form roundly elliptical, the cephalic extremity sometimes slightly depressed; dorsum slightly convex; abdominal segments moderately distinct. Length about $\frac{1}{30}$in. The dorsum bears, some distance within the margin, a series of twenty-two tubercular pores, glands, or spinneret orifices. Of these, four on the extreme cephalic region are small, with simple circular orifices; the next two (one on each side), on a level with the rostrum, are large and conspicuous, consisting of a cylindrical tube with wide circular orifice; the next four (two on each side) on the median thoracic region are rather small, but larger than the anterior cephalic ones, and have circular multilocular orifices; the next eight (four on each side) on the abdominal region are similar to the two large ones near the rostrum; the last four (two on each side) near the abdominal extremity are about equal in size to the four on the cephalic region, and are simple. The margin is very finely striated, but not crenulated; and for some distance within it the dorsum

is covered with great numbers of very small simple circular spinneret-orifices, but these do not extend to the median dorsal regions. There is no fringe, properly speaking, but all the organs just described produce secretion, as noticed presently. Vasiform orifice rather broader than long, the anterior edge slightly concave, the posterior edge broadly convex; operculum small, covering about one-third of the orifice, with both edges concave, the anterior very deeply, the posterior less, depressed; lingula very long, extending some distance from the orifice, roundly conical, with two rather long setæ near its end.

The spinneret tubes and orifices above mentioned secrete a large quantity of snow-white waxy threads closely felted, and also, scattered amongst these, several long straight glassy rods, which are very brittle; these rods, when closely examined, are seen to be very delicately fluted. The threads appear to be produced from the very numerous minute spinnerets, and the rods from the rows of larger tubes. It results from the absence of small spinnerets on the median dorsal regions that the pupa-case in those parts is uncovered; consequently, it appears as if lying on a thick ring or cushion of cotton, from which fact I have derived its specific name.

On turning over the pupa-case and dissolving the waxy matter, the rudimentary feet and antennæ are clearly visible; the feet are thick and short, the antennæ rather long, slender, and in the latest stage numerously ringed.

Adult form unknown; but from the appearance of the rudimentary wings in a late pupa examined, which was almost on the point of emerging when it died, I believe that the fore-wings will be dark and banded with dark-brown, or perhaps black.

*Hab.* In Trinidad, West Indies. My specimens were sent by Mr. F. W. Urich. I think the plant is *Jatropha* sp.

It has been necessary to be particular in describing and figuring the details of spinnerets, &c., in this species, on account of its similarity in some respects to three West Indian insects: *Aleurodicus anonæ*, Douglas and Morgan; *A. cocois*, Curtis; and *A. ornatus*, Cockerell. I have already, in my introductory remarks, mentioned that these and other authors employ frequently the term "larva" to denote indiscriminately what I take to be both the larval and the pupal states. Now, first, as to colour: the "larva" of *A. anonæ* is said to be "ochreous"; that of *A. cocois* (as far as I can make out) is similar; that of *A. ornatus* is "grey." No author mentions dark longitudinal brown bands, such as those which are so conspicuous in *A. pulvinata*. What is much more important, in *A. anonæ* Mr. Morgan gives fourteen "lateral infundibuliform compound spinnerets" and "secreting glands"; *A. cocois*

(sp. Riley and Howard) has also fourteen; *A. ornatus* has glands "practically as in *A. anonæ*"; but in *A. pulvinata* there are twenty-two of these organs. No author mentions minute dorsal spinnerets within the margin, such as those which are so extremely numerous in *A. pulvinata;* yet, as these appear to be certainly the producers of the ring of waxy threads, they are of importance. As regards the vasiform orifice and lingula, I find those of *A. anonæ* (which Mr. Morgan curiously terms the "anus, colon, and ilium") and those of *A. cocois* not greatly dissimilar; in fact, they may be said to be practically identical. These organs are not mentioned for *A. ornatus*. In the figure 41B of *A. cocois* (Ins. Life, 1893, p. 314) the lingula of the adult female is shown as protruding considerably from the abdomen; probably this will also be the case in *A. pulvinata*.

I believe that the wings of *A. pulvinata* will be not far removed from the darkly-banded ones of *A. ornatus;* but in the face of the statement that the "larva" of that species is "grey," and in the absence of any further information, I shall not at present so identify the insect, nor shall I yet relegate it to the genus *Aleurodicus*.

49. **Aleurodes quercûs,** Signoret. Ann. de la Soc. Entom. de France, Dec., 1867, p. 384.

50. **Aleurodes ribium,** Douglas. Ent. Mo. Mag., 1888, p. 265; 1889, p. 256.

51. **Aleurodes rubi,** Signoret. Ann. de la Soc. Ent. de France, Dec., 1867, p. 382.

52. **Aleurodes rubicola,** Douglas. Ent. Mo. Mag., 1891, p. 322.

53. **Aleurodes sacchari,** Maskell. Trans. N.Z. Inst., 1889, p. 171.

The vasiform orifice of this species is situated on a projecting tubercle; it is broader than long, with slightly concave anterior edge; operculum covering nearly all the orifice; lingula obsolete.

54. **Aleurodes simplex,** Maskell. Trans. N.Z. Inst., 1889, p. 175.

The vasiform orifice in the pupa is elongate, subconical, with nearly straight anterior edge; operculum small, scarcely covering a fourth of the orifice; lingula extending a short distance beyond the operculum, but not reaching the edge of the orifice, cylindrical, with the extremity slightly dilated and emarginate.

The adult (unknown in 1889) is pale-yellow all over; the

wings are entirely immaculate, with minutely serrated margins. Genitalia normal.

The abdominal cleft and emarginate lingula of this species (especially the former) will distinguish it from *A. rubicola*.

55. **Aleurodes stellata,** Maskell, sp. nov. Plate XXXIV.—2.

Larva light-brown, elliptical, flat; length about $\frac{1}{80}$in. Margin minutely crenulated, but without a fringe.

Pupa-case dark-brown, sometimes black; elliptical; very slightly convex, with a median longitudinal ridge; length about $\frac{1}{30}$in. Abdominal segments indistinct. Dorsum covered with white meal, which frequently becomes rather thick and solid; this meal is secreted by dorsal pores, which it is not easy to make out on account of the blackness of the case; there seem to be two large ones on the cephalic region and two on the thoracic, also four smaller on the abdomen, and the whole dorsum is marked with very numerous minute dots, which may be orifices of spinnerets. The margin is conspicuously crenulated, and bears a long fringe of white waxy tubes, which become agglomerated into almost a solid plate; these tubes are longer in some places than in others, so that the fringe presents the appearance of a star with usually about eight rays. Vasiform orifice small, roundly subconical, the anterior edge straight; operculum subsemicircular, covering about half the orifice; lingula obsolete.

Adult form unknown.

*Hab.* In Jamaica, on *Lignum vitæ*, in company with *A. floccosa*. Specimens from Mr. Cockerell.

56. **Aleurodes spirææ,** Douglas. Ent. Mo. Mag., 1894, pp. 73, 154.

57. **Aleurodes styphelisæ,** Maskell, sp. nov. Plate XXXV.—1.

Eggs oval, yellow.

Larva very dark-brown; elliptical, flattish; abdominal segments distinct; length about $\frac{1}{50}$in. Dorsum bearing a few hairs. Margin very conspicuously striated and crenulated, with scarcely any, if any, fringe. When the larval exuviæ are attached to the pupa-case the anterior edge is recurved, giving the larva a truncate appearance.

Pupa-case very dark-brown, or glossy-black; elliptical, with the abdomen rather tapering; length about $\frac{1}{40}$in. Dorsum convex, with a median longitudinal ridge, and distinct abdominal segments. On the dorsum there are two long spiny hairs situated on the centre of the thoracic region; and there are also some very minute pores in two rows on the abdominal segments; from these pores is secreted some scanty and fragmentary white meal. Margin very conspicuously tubular and crenulated, and bearing a fringe of white

waxy tubes, which are frequently as long as the breadth of the pupa-case. The larval exuviæ are almost always attached to the pupal dorsum by the two long hairs of the latter. Vasiform orifice with a concave anterior edge, the sides and end broadly rounded; operculum large, with emarginate sides, almost covering the whole orifice; lingula apparently obsolete.

Adult form unknown.

*Hab.* In Australia, on *Styphelia (Monotoca) richei.* My specimens were sent by Mr. C. French, from Melbourne, and by Mr. Froggatt, from Sydney.

58. **Aleurodes T-signata,** Maskell, sp. nov. Plate XXXV.—2.

Larva very dark-brown, or to the naked eye quite black; elliptical; dorsum convex, with a longitudinal raised ridge and distinct abdominal segments; length about $\frac{1}{50}$in. The dorsum bears twenty-four large, thick spines, with blunt rounded ends—eight (in two transverse rows) on the cephalic region, four on the thoracic region, and twelve (in two longitudinal rows) on the abdomen; between the four on the thorax are four smaller ones on the median region. These spines bear short curling tubes of white wax. Margin deeply crenulated, and bearing a short fragmentary white fringe.

Pupa-case intense glossy black; elliptical; dorsum convex, with a median longitudinal ridge, which is broader and thicker than that of the larva; length about $\frac{1}{25}$in. The cephalic extremity is very frequently acuminate. Dorsum bearing large spines which are arranged somewhat differently from those of the larva, those on the cephalic region forming a submarginal series instead of transverse rows. There are also more numerous small spinnerets—eight on the cephalic region, six on the thoracic, twelve on the abdomen, and two close to the vasiform orifice; besides which, on the centre of the first abdominal segment, there are two large spines. There are thus forty-eight spinnerets (large and small) on the pupa, instead of twenty-eight as in the larva. Margin very conspicuously and deeply crenulated, and bearing a fringe of white waxy tubes, usually of some length, but the fringe is often fragmentary and sometimes quite broken off. Vasiform orifice small, subsemicircular; operculum small, covering half the orifice; lingula obsolete. At the abdominal extremity there are two moderately long hairs, and these hairs frequently carry a pencil of white wax longer than the fringe.

The pupa, when extracted from its case, is yellow, with the divisions of the thorax and abdomen marked by darker colour; the wings, eyes, feet, and antennæ partly developed, the eyes reniform, dark-brown; the whole is enclosed in a very thin translucent membrane which lines the pupa-case.

Adult of normal form. The head and thorax are dark-brown, patched with yellow; the abdomen is yellow, with the genitalia and the dorsal cornicle brown; feet and antennæ brownish-yellow. Antennæ normal, with seven joints. Feet long and slender; claws normal. Forewings exhibiting four light-crimson patches—one small rhomboidal patch close to the anterior margin at about half its length; a second, sub-rectangular, near the point of curvature of the anterior margin; a third, of irregular shape, opposite the second, but not touching the posterior margin; and a fourth, broadly T-shaped, the base of the T springing from the posterior margin at its most concave point. Genitalia of female sharply conical; genitalia of male not observed. In the dorsal cornicle the lingula does not protrude, and is probably obsolete, as in the pupa.

*Hab.* In Australia, on *Acacia longifolia*. My specimens were sent by Mr. Froggatt, from Botany, near Sydney.

The very thick and strong spines of the larva and pupa distinguish this species from *A. banksiæ*, in which they are much more slender, though somewhat similarly arranged.

59. **Aleurodes tinæoides** (*auctor ?*). Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 399.

60. **Aleurodes vaccinii**, Künow. Entom. Nachricht., 1880, vi., p. 46; Douglas, Ent. Mo. Mag., 1880, p. 89; *ib.*, 1889, p. 256.

61. **Aleurodes vaporariorum**, Westwood. Gard. Chron., 1856, p. 852; Frauenfeld, Verh. der Zool.-Bot. Gesellsch., Wien, 1867, p. 798; Signoret, Ann. de la Soc. Ent. de France, Dec., 1867, p. 387; Douglas, Ent. Mo. Mag., 1886, p. 164.

62. **Aleurodes xylostei**, Westhoff. Jahresber. Zool. Westfäl. Verein, 1886, p. 56; Karsch, Entom. Nachricht., 1888, xiv., p. 31.

### Genus Aleurodicus, Douglas and Morgan.

General characters of *Aleurodes*; vein of forewing branched a second time near its extremity.

In the diagnosis of this genus Mr. Morgan (Ent. Mo. Mag., 1892, p. 31) states that the structure of the genital organs of the male is "different from any species of the genus *Aleurodes*." I have been unable to detect any such difference. Under *A. anonæ* the genitalia of the male are said to be "in form of a forceps, between which lies the penis," and are so figured (*loc. cit.*, plate i., fig 4). Signoret, in his generic characters of *Aleurodes*, says, "Extremity of the male ab-

domen ending in an organ formed like a forceps" (p. 378). And in all the species which I have seen this feature is quite constant, as shown in the figures attached to this paper. I cannot therefore include this amongst the generic characters of *Aleurodicus*.

In a note to the same diagnosis (*loc. cit.*, p. 32) Mr. Douglas says further that *Aleurodicus* differs from *Aleurodes* "in the characteristics of the larva." But nothing is given in the description of the text which is any more than a *specific* difference, and I cannot see how the larva is to be employed for *generic* purposes.

The doubly-branched nervure is, however, a sufficient character for separation.

1. **Aleurodicus anonæ,** Douglas and Morgan. Ent. Mo. Mag., 1892, vol. xxviii., p. 32.

2. **Aleurodicus asarumis,** Shimer. Trans. Amer. Entom. Soc., vol. i., p. 281.

This species is here placed in the genus *Aleurodicus* on the authority of Messrs. Riley and Howard, *Insect Life*, 1893, p. 219.

3. **Aleurodicus cocois,** Curtis. *Aleurodes cocois*, Curtis, Gard. Chron., 1846, p. 284; Signoret, Ann. de la Soc. Ent. de France, 1867–68, p. 398; *Aleurodicus*, Douglas and Morgan, Ent. Mo. Mag., 1892, p. 32; Riley and Howard, *Insect Life*, 1893, p. 314.

4. **Aleurodicus ornatus,** Cockerell. Ent. Mo. Mag., 1893, p. 105.

## INDEX TO PLATES XXIV.-XXXV.

### PLATE XXIV.—1.

***Types of details; greatly magnified.***

*a.* Type of adult *Aleurodes*.
*b.* Head of adult viewed from above.
*c.* Head of adult viewed from beneath, showing rostrum and mentum.
*d.* Head of adult viewed sideways, showing rostrum and mentum.
*e.* Antenna of adult.
*f.* Eye of adult.
*g.* Foot of adult.
*h.* Last joint of tarsus and claws.

### PLATE XXIV.—2.

***Types of details; greatly magnified.***

*a.* Type of wings of *Aleurodes*.
*b.* Type of forewing of *Aleurodicus*.
*c, d, e, f,* types of marginal serrations of wings: *c, A. asplenii*; *d, A. piperis*; *e, A. asparagi*; *f, A. T-signata*.

*g.* Vasiform orifice, operculum, and lingula, normal form with retracted lingula.
*h.* Vasiform orifice seen from the side, lingula retracted.
*k.* Vasiform orifice seen from the side, lingula extended.
*l.* Type of female genitalia seen from above.
*m.* Type of female genitalia seen from the side.
*n.* Male genitalia (*A. asplenii*) seen from above.
*o.* Male genitalia (*A. comata*) seen from above.
*p.* Type of male genitalia, seen from the side.

PLATE XXV.—1.

*Aleurodes banksiæ.*

*a.* Larvæ and pupæ on leaf.
*b.* Diagram of larva, showing arrangement of spines.
*c.* Spine of larva, more highly magnified.
*d.* Vasiform orifice and operculum (diagram).
*e.* Margin of larva.
*f.* Pupa-case, dorsal view.

PLATE XXV.—2.

*Aleurodes barodensis.*

*a.* Larvæ, pupæ, and eggs, on leaf, enlarged.
*b.* Larva, dorsal view.
*c.* Diagram of larva, showing arrangement of pores.
*d.* Margin of larva and pupa.
*e.* Vasiform orifice, operculum, and lingula.

PLATE XXVI.—1.

*Aleurodes cerata.*

*a.* Larvæ and pupæ on leaf.
*b.* Pupa-case, dorsal view, enlarged.
*c.* Diagram of pupa-case, showing pores.
*d.* Margin of larva and pupa.
*e.* Vasiform orifice, operculum, and lingula (diagram).

PLATE XXVI.—2.

*Aleurodes comata.*

*a.* Larvæ and pupæ on leaf.
*b.* Diagram of larva, showing hairs.
*c.* Margin of larva.
*d.* Pupa-case, showing enclosed insect.
*e.* Margin of pupa-case.
*f.* Vasiform orifice and operculum (diagram).
*g.* Forewing of adult.
*h.* Margin of wing of adult.
*k.* Genitalia of adult male (diagram).

PLATE XXVII.—1.

*Aleurodes cotesii.*

*a.* Larvæ and pupæ on leaf.
*b.* Larva, dorsal view, enlarged.
*c.* Margin and dorsal pores of larva.
*d.* Pupa-case, dorsal view, enlarged.
*e.* Margin of pupa-case.
*f.* Pupa-case, side view.
*g.* Vasiform orifice, operculum, and lingula (diagram).

PLATE XXVII.—2.

*Aleurodes croceata.*

*a.* Pupæ on leaf.
*b.* Diagram of larva, showing spines.
*c.* Pupa-case, dorsal view.
*d.* Margin of pupa-case.
*e.* Vasiform orifice, operculum, and lingula (diagram).

PLATE XXVIII.—1.

*Aleurodes decipiens.*

*a.* Larvæ and pupæ on leaf.
*b.* Larva, dorsal view.
*c.* Margin of larva.
*d.* Vasiform orfice, operculum, and lingula of larva (diagram).
*e.* Pupa-case (?), dorsal view.
*f.* Abdominal extremity of pupa-case (semi-diagram).

PLATE XXVIII.—2.

*Aleurodes erigerontis.*

*a.* Pupæ on leaf.
*b.* Pupa-case, dorsal view.
*c.* Margin of pupa-case.
*d.* Diagram of pupa-case, showing papillæ and pores.
*e.* Vasiform orifice, operculum, and lingula (diagram).
*f.* Eye of pupa, after treatment, side view.

PLATE XXIX.—1.

*Aleurodes eugeniæ.*

*a.* Pupæ on leaf.
*b.* Pupa-case, showing enclosed insect.
*c.* Diagram of pupa-case, showing radiating patches.
*d.* One of the radiating patches, enlarged.
*e.* Margin of pupa-case.
*f.* Vasiform orifice, operculum, and lingula (diagram).

PLATE XXIX.—2.

*Aleurodes eugeniæ*, var. *aurantii.*

*a.* Pupæ on leaf.
*b.* Pupa-case, showing enclosed insect.
*c.* Diagram of pupa-case, showing radiating patches.
*d.* One of the radiating patches, enlarged.
*e.* Margin of pupa-case.
*f.* Vasiform orifice, operculum, and lingula (diagram).

PLATE XXX.—1.

*Aleurodes floccosa.*

*a.* Larvæ and pupæ on leaf.
*b.* Diagram of larva, showing spines.
*c.* Lanceolate spines of larva, enlarged.
*d.* Pupa-case with attached larva, dorsal view.
*e.* Dorsal spines of pupa-case, enlarged.
*f.* Margin of pupa-case.
*g.* Vasiform orifice and operculum (diagram).

### Plate XXX.—2.

*Aleurodes fodiens.*

*a.* Pupæ on leaf.
*b.* Pupa in pit on under-surface of leaf.
*c.* Elevation on upper surface of leaf.
*d.* Pupa case, showing enclosed insect.
*e.* Margin of pupa-case.
*f.* Vasiform orifice, operculum, and lingula (diagram).

### Plate XXXI.—1.

*Aleurodes hirsuta.*

*a.* Larvæ and pupæ on leaf.
*b.* Diagram of larva, showing arrangement of spines.
*c.* Diagram of pupa-case, showing arrangement of spines.
*d.* Spine of pupa-case, enlarged.
*e.* Margin of pupa-case.
*f.* Vasiform orifice and operculum (diagram).

### Plate XXXI.—2.

*Aleurodes holmesii.*

*a.* Larvæ and pupæ on leaf.
*b.* Pupa-cases, dorsal and side views.
*c.* Diagram of pupa-case, showing spines.
*d.* Margin of pupa-case.
*e.* Vasiform orifice, operculum, and lingula (diagram).
*f.* Extremity of lingula, enlarged.

### Plate XXXII.—1.

*Aleurodes limbata.*

*a.* Larvæ and pupæ on leaf.
*b.* Pupa-case with attached larval exuviæ.
*c.* Margin of pupa-case.
*d.* Vasiform orifice and operculum (diagram).

### Plate XXXII.—2.

*Aleurodes nicotianæ.*

*a.* Larvæ and pupæ on leaf.
*b.* Diagram of larva, showing depressions and marginal hairs.
*c.* Pupa-case, dorsal view.
*d.* Diagram of pupa-case, showing pustules.
*e.* Margin of pupa-case, with pustules.
*f.* Vasiform orifice, operculum, and lingula (diagram).

### Plate XXXIII.—1.

*Aleurodes niger.*

*a.* Pupæ on leaf.
*b.* Pupa-case, dorsal view.
*c.* Margin of pupa-case.
*d.* Vasiform orifice and operculum (diagram).

### Plate XXXIII.—2.

*Aleurodes piperis.*

*a.* Larvæ and pupæ on leaf.
*b.* Pupa-case, dorsal view, with attached larval exuviæ.
*c.* Margin of pupa-case.

*d.* Vasiform orifice, operculum, and lingula (diagram).
*e.* Pupa extracted from case, dorsal view.
*f.* Forewing of adult.

PLATE XXXIV.—1.

*Aleurodes pulvinata.*

*a.* Pupæ on leaf.
*b.* Pupa-case, dorsal view.
*c.* Pupa-case, ventral view, showing enclosed insect.
*d.* Diagram of pupa-case, showing arrangement of pores.
*e.* Margin of pupa-case, showing dorsal spinnerets.
*f.* Vasiform orifice, operculum, and lingula (diagram).

PLATE XXXIV.—2.

*Aleurodes stellata.*

*a.* Larvæ and pupæ on leaf.
*b.* Pupa-case, dorsal view.
*c.* Margin of pupa-case.
*d.* Vasiform orifice and operculum (diagram).

PLATE XXXV.—1.

*Aleurodes stypheliæ.*

*a.* Larvæ and pupæ on leaf.
*b.* Pupa-case, dorsal view, showing attached larval exuviæ.
*c.* Margin of pupa-case.
*d.* Vasiform orifice and operculum.

PLATE XXXV.—2.

*Aleurodes T-signata.*

*a.* Larvæ and pupæ on leaf.
*b.* Diagram of larva, showing arrangement of spines.
*c.* One spine of larva, enlarged.
*d.* Pupa case, dorsal view.
*e.* Margin of pupa-case.
*f.* Pupa extracted from case, dorsal view.
*g.* Forewing of adult.

## ART. XL.—*Zoological Notes, Nelson District.*

By R. I. KINGSLEY.

[*Read before the Nelson Philosophical Society, 13th January, 1896.*]

**Eurystomus pacificus** (Australian Roller).

The first-recorded occurrence of this bird in New Zealand, according to Sir Walter Buller, was in 1881, when Mr. F. E. Clarke reported it in a paper read before the Westland Institute (*vide* Trans. N.Z. Inst., vol. xiii., p. 454); and about the same time four other specimens were obtained in three other places, making altogether five specimens. The localities were far apart, but all situate on the west coast of the two Islands.

Last April (1895) the presence of a strange bird was noticed at Stoke, near the sea-shore, west of the entrance to Nelson Harbour. Mr. C. Martin states several members of his family noticed its peculiar flight and heard its cry. Mr. A. E. Green also saw it, and the latter gentleman found it dead on the sands on the 17th April, and sent it to a taxidermist, when it was found to be too decomposed to preserve. It was afterwards given to me, and proved to be a specimen of the Australian Roller. I embalmed it, in order to keep the body for reference.

It is stated by Sir Walter Buller, on the authority of Messrs. Cayley and Gould, that the Australian Roller is very local in its habitat in New South Wales, arriving there from the north not earlier than October and disappearing in February. If this is the case, it appears very strange to find in the month of April in New Zealand a bird which should, in the natural order of events, have been at that time in its winter habitat in New Guinea. The other recorded instances apparently occurred at such time as the bird would in an ordinary case have been in New South Wales.

**Scale Insect** (*Planchonia quercicola*).

In December, 1894, I noticed at Stoke a scale insect on the oaks on Mr. Marsden's property; specimens were forwarded to Mr. Maskell, who identified it as *Planchonia quercicola*, a species hitherto not recorded as found in New Zealand. As I understand Mr. Maskell intends to describe it, I shall confine myself to the result of inquiries and observation as to its occurrence in this district. It appears it has been at Stoke something like fourteen years; the owner lately has checked its increase by pruning and cutting down badly-infested trees. In Nelson itself about seven or eight years ago an oak badly attacked was cut down and burnt in the grounds near the Provincial Buildings. Near by, in grounds adjoining the brewery, is an oak with the insects plainly visible; in Trafalgar Square and on the Church Hill I noticed its presence; also on an oak in St. Paul's Churchyard, Brightwater; and at the entrance-gates of the residence of the Bishop of Nelson stand two oaks, one badly infested, but, curiously enough, the other apparently quite free.

At present I am unable to give an opinion as to whether the insect is increasing rapidly or not; very possibly the presence of its natural enemy may account for the fact that no great damage such as occurred in the Bois de Boulogne, Paris, about sixty years ago has as yet been done. It would, however, be well if the several owners would prune the diseased branches, and thus keep it in check.

ART. XLI.—*Animal and Vegetable Parasites associated with the Production of Neoplasms in Cattle and Sheep.*

By ARCHIBALD PARK, M.R.C.V.S.

Communicated by Sir J. Hector.

[*Read before the Wellington Philosophical Society, 17th July, 1895.*]

I DID not expect to be called upon to address such a learned body as the members of the Philosophical Society in this colony. When I left Tasmania I merely put up a few preparations to show Sir James Hector the progress I have made since he visited my laboratory in Hobart in October, 1893. Of course you are all aware that tuberculosis is the disease that we are led to believe is dangerous above all others in consuming the flesh of animals affected by it. During the early part of my professional career I was quite satisfied to accept the testimony of what was considered to be reliable investigation; but when Dr. Creed, of Sydney, New South Wales, so warmly took up the subject of tuberculosis in rabbits, in 1883, and by his influence Mr. Anthony Willows, M.R.C.V.S., was despatched to Tasmania to investigate the disease in that colony, I was enabled to see what Mr. Willows pronounced to be tuberculosis, scrofula, cancer, &c. My experience in the Old Country twenty years before enabled me to pronounce an adverse opinion at the time, and, having since struck out a line of investigation for myself on this important subject, I find that no one has yet demonstrated the existence of tuberculosis in wild rabbits, as the disease so frequently alluded to is the well-known *Coccidium oviforma*. Then, the "scrofula" in cattle as reported by Mr. Willows proves to be the now well-known actinomycosis; and I am glad to say no case of tuberculosis has yet been found in Tasmania, notwithstanding the alarming report circulated by the New South Wales Stock Department in 1884. I have spent eighteen years in Tasmania, and have taken every opportunity to find tuberculosis in cattle in that colony, but up to the present time I have not succeeded. It has always occurred to me, Why should tuberculosis be so prevalent in these colonies (I mean in Australasia) as is reported? There must be something wrong somewhere; so, still endeavouring to solve the mystery, I obtained permission and assistance from Mr. P. R. Gordon to visit Queensland in 1893, and went on to several stations where cattle were not knocked about, as would have been the case if I had only made examinations at boiling-down establishments. After making over

seventy *post mortems* in 1893, I felt convinced that tuberculosis could be easily demonstrated in some cases, but yet could not understand why it should appear to be preceded by an animal parasite—viz., *Spiroptera reticulata*. The photographs and specimens which I exhibit will show the nature of the tumours, of the size of a pea to the size of a large cocoanut, in which is enclosed the worm which produces the lesions referred to.

Of the life-history of these parasites I am unable to give any account, except that they are never found until an animal has passed at least one summer of its existence on the pastures, nor am I able to explain the way in which they gain entrance to the body; but it would appear that they are probably lodged in the connective tissue by means of the circulation, as the embryos are seen free in the tissue. On the other hand, if the adult female should attach itself from without, it could easily penetrate the fauces and gain entrance to the connective tissue, gliding down the neck to the brisket, where they are most commonly found, always lying between groups of muscles, and as low down as the stifle-joint. Sometimes very large tumours are found at that point.

I issued a report to the Queensland Government pointing out the association of the animal and vegetable parasite existing in the same tumour, and in my opinion the *Spiroptera reticulata* caused much of the mischief done (a primary lesion). At the same time I prepared and sent to Dr. M. Armand Ruffer a section of the tumours, and in December following I received a letter confirming the observation made by me. This letter is appended hereto.

In a letter signed "S. Bradbury," in the *Live-stock Journal*, New South Wales, it is suggested that, if the statement made by me were true, then 50 per cent. of cattle must be affected with tuberculosis; also, that such a statement, if unchallenged, would damage the stock interests of the colony. In the meantime the Queensland Government had requested me to undertake another journey and further investigate the disease, and I carefully noted that sixty-three out of seventy-seven cattle submitted to me for examination harboured *Spiroptera reticulata*, or 80 per cent. instead of 50 per cent.: my 1894 examination thus confirming more fully the statements of the previous year. By the specimens in the tube you will observe every stage of degeneration. Under the microscopes are sections of the tumours showing tubercle bacilli, while the phagocites are seen destroying and digesting the *Spiroptera*. Unless one studies this subject closely it seems almost incredible that the cells in our bodies could attack and destroy an animal so large as a worm; nevertheless it is a fact, and this is the "zooparastic tuber-

culosis" of Metchnikoff. It is also very clearly seen in the lungs of sheep and in the intestines as small knobs. When we find a large number of encysted parasites of this kind it is easy to see how readily one can mistake such cases for tuberculosis, especially when no microscopic examination is made, as in sheep they cannot be seen without a lens of some kind.

Cancer is the next subject to command attention. This is said to be due to the consumption of animal food affected with cancer. For my own part, I have no proof of this, but I can show you specimens of the latest form of cancer-parasites in man, and also certain intracellular bodies in cattle that bear a striking resemblance to those bodies as described by Ruffer, Walker, Fox, and others; but, until we have proof of the statements made concerning cancerous meat, I would say, keep a contented mind until proof is obtained.

In order to prove what I have said, we will now examine the preparations, under the microscopes, of cancer, actinomycosis, tuberculosis, *Spiroptera reticulata*, and also a preparation by Dr. Whittell, of Adelaide, of actinomycosis and *Spiroptera reticulata* in the same tumour, giving further proof of another vegetable parasite finding a nidus in the same tumour.

5, York Terrace, Regent's Park, N.W., London,
8th December, 1893.

DEAR MR. PARK,—

I was very glad to hear from you again, and to have an account of your extremely interesting observations. I am also greatly obliged to you for the thirteen beautiful sections you have sent me, which I have examined with the greatest interest.

There is not a doubt that these preparations represent sections through some kind of new growth, which form cysts containing in their interior a peculiar-looking worm, which resembles marvellously and is probably identical with the *Spiroptera reticulata*.

In some of the sections one could also see large giant cells, which were evidently filled with all kinds of *débris*, which were probably bits of embryos, or even of adult worms, which these giant cells had taken into their interior, killed, and digested. The worms varied to a great extent, and, in some, one could see the process of the formation of embryos, &c.

I was greatly interested also in some of the sections which showed the *Spiroptera* as well as the tubercle bacilli at the periphery.

I must say that this discovery of yours strikes me as being entirely new, and one which might prove useful in elucidating various pathological problems.

It strikes me as exceedingly probable that the *Spiroptera* penetrates first, and then, through the irritation which it produces, and through its altering of the animal's resistance, it gives the tubercle bacillus a chance to invade the body and thrive; but I do hope that you and your assistants will work out this most interesting problem.

I was also greatly interested in the notes of cattle slaughtered by you during the year 1893 in Queensland. There can be no doubt from your list that true tubercle must be exceedingly rare, and that actinomycosis and diseases due to worms, *Spiroptera*, &c., must be equally common. I confess I should have been greatly astonished had tubercle been as fre-

quent as it is generally said to be, for the conditions which appear to favour the occurrence of tubercle seem to be absent in your country.

You must not be disappointed if the veterinarians pooh-pooh your observations. It is the best proof that you can have that they are really original; and I think you are doing good service by showing the occurrence of two parasites belonging to two kingdoms in one and the same animal, and even in one and the same tumour.

I hope that if you have any material to spare you will send us some over, as now that the British Institute of Preventive Medicine is in working-order I shall be able to get the pathological anatomy worked out in London.

Yours very truly,
M. Armand Ruffer.

## Art. XLII.—*Notes on the* Cicadidæ *of New Zealand.*

By W. F. Kirby, F.L.S., F.E.S., Assistant in Zoological Department, British Museum (Natural History), South Kensington, London.

Communicated by G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

Through the kindness of Mr. G. V. Hudson I have lately received a very interesting series of specimens, which will enable me to clear up the synonymy of most of the New Zealand species of *Cicadidæ*.

Very few species are at present known, all of which belong to the genus *Melampsalta*, Amyot, which may be recognised by the long narrow basal cell of the tegmina, from the lower and outer angle of which one nervure only, which soon bifurcates, is emitted, instead of two.*

This genus is widely distributed in the Old World, but is particularly numerous in the Australian region, where it is the largest and one of the most characteristic genera of *Cicadidæ*.

A list of the *Cicadidæ* of New Zealand was published by Captain Hutton in 1873, in which twelve species were enumerated; and in 1879 Dr. Buchanan White published a revised list in the *Entomologists' Monthly Magazine*, xv., pp. 213, 214, describing one species, but reducing the total number to nine. Since then Mr. Hudson has discussed the New Zealand species in the "Transactions of the New Zealand Institute," vol. xxiii., and in his "Manual of New Zealand Insects."

The species now known to me are as follow:—

* For tegmina of *M. cingulata* see figure on pl. ix., Trans. N.Z. Inst., vol. xxiii.

I. MELAMPSALTA CINGULATA, Fabr.

*Tettigonia cingulata*, Fabr., Syst. Ent., p. 680, n. 9 (1775).

*Cicada cingulata*, Hudson, Trans. N.Z. Inst., xxiii., p. 50, pl. 9 (1891); Man. N.Z. Ins., p. 118, pl. 20, figs. 1, 1*a* (1892).

*Cicada zealandica*, Bond, Voy. "Astrolabe," Ent., p. 611, pl. 10, fig. 6 (1832); Walker, List Homopt. Ins. B. M., i., p. 159, n. 98 (1850); iv., p. 1125 (1852).

*Cicada indivulsa*, Walker, *l.c.*, Suppl., p. 33 (1858).

*Cicada cingulata*, var. *obscura*, Hudson, *l.c.*, p. 51 (1891).

By far the largest of the New Zealand species. The types are in the Banksian Collection in the British Museum.

*C. indivulsa*, Walker, was described from a bleached specimen. There are no specimens of this or of any allied species from Australia in the Museum except *M. convergens* (*Cicada convergens*, Walker, List Homopt. Ins., i., p. 114, n. 120, 1850), which is very distinct from *M. cingulata* by the nearly black abdomen, with the incisions very narrowly reddish; the two short basal stripes on the mesothorax, which are fused into one large one; and the distinct black line bounding the costal area on its lower edge. Of this species there are two rather indifferent specimens in the Museum; but neither *M. cingulata* nor *M. convergens* appears quite to agree with p. 289, which was described from Sydney, and subsequently the description of *Cicada flavicosta*, Stäl, Eugenie's *Resa*, indicated as a synonym of *M. cingulata*.

II. MELAMPSALTA MUTA, Fabr.

There are several distinct forms which Mr. Hudson considers to be varieties of this species. I express no opinion on the subject, but have attempted to give the correct synonymy below, in the order adopted by Mr. Hudson:—

α. *Muta*, Fabr.

*Tettigonia muta*, Fabr., Syst. Ent., p. 681, n. 17 (1775).

*Cicada muta*, var. *subalpina*, Hudson, Trans. N.Z. Inst., xxiii., pp. 51, 52 (1891); Man. N.Z. Ins., p. 119, pl. 20, fig. 2 (1892).

The types in the Banksian Collection show this to be the typical form of the species.

β. *Cruentata*, Fabr.

*Tettigonia cruentata*, Fabr., Syst. Ent., p. 680, n. 10 (1775).

*Cicada rosa*, Walker, List Homopt. Ins., i., p. 220, n. 173 (1850).

*Cicada bilinea*, Walker, *l.c.*, Suppl., p. 34 (1858).

*Cicada muta*, var. *rufescens*, Hudson, Trans. N.Z. Inst., xxiii., p. 52 (1891).

The type of this form is also in the Banksian Collection. Walker's *C. bilinea* is one of the female specimens alluded to by Mr. Hudson.

γ. *Flavescens*, Hudson.

*Cicada muta*, var. *flavescens*, Hudson, Trans. N.Z. Inst., xxiii., p. 52 (1891).

I have not seen this form.

δ. *Angusta*, Walker.

*Cicada angusta*, Walker, List Homopt. Ins., i., p. 174, n. 121 (1850).

*Cicada muta*, var. *cinerescens*, Hudson, Trans. N.Z. Inst., xxiii., p. 52 (1891).

ε. *Cincta*.

*Cicada cincta*, Walker, List Homopt. Ins. B. M., i., p. 204, n. 156 (1850).

*Cicada muta*, var. *minor*, Hudson, Trans. N.Z. Inst., xxiii., p. 52 (1891).

Walker's description is taken from a discoloured specimen.

III. Melampsalta cuteræ.

*Cicada cutera*, Walker, List Homopt. Ins. B. M., i., p. 172, n. 116 (1850).

*Cicada orbrina*, Walker, *l.c.*, Suppl., p. 34 (1858).

*Cicada aprilina*, Hudson, Trans. N.Z. Inst., xxiii., p. 53 (1891); xxv., p. 163 (1893).

A long series of this insect stood in the British Museum collection under the name of *Cicada muta*, among which were only two specimens really belonging to the latter species. This is probably the reason why Mr. Distant so positively maintains that *C. aprilina* is not distinct from *C. muta*.

IV. Melampsalta sericea, Walker.

*Cicada sericea*, Walker. List Homopt. Ins. B. M., i., p. 169, n. 118 (1850).

This insect differs from *M. scutellaris* much as *M. muta*, form *angusta*, differs from the form *rufescens*. The single specimen is from Auckland. The eighth apical cell is, how-

ever, of the same shape as in *M. muta*, and it may be a form of that species.

V. MELAMPSALTA SCUTELLARIS, Walker.

*Cicada scutellaris*, Walker, List Homopt. Ins. B. M., i., p. 150, n. 88 (1850).

*Cicada arche*, Walker, *l.c.*, p. 195, n. 146 (1850).

*Cicada tristis*, Hudson, Trans. N.Z. Inst., xxiii., p. 52 (1891).

The type of *scutellaris*, Walker, is a small male in fair condition, "collected by Earl," but without exact locality, in which the dark markings of the mesothorax are almost obliterated. The type of *arche* is a specimen bleached almost beyond recognition. *M. scutellaris* appears to be a variable species, and in some of its forms it approaches *M. muta*. It may, however, easily be distinguished from *M. muta* by the eighth apical cell of the tegmina, which is fully twice as long as broad, and in *M. muta* not much longer than broad.

VI. MELAMPSALTA NERVOSA, Walker.

*Cicada nervosa*, Walker, List Homopt. Ins. B. M., i., p. 213, n. 166 (1850).

This species has always reddish markings, and does not vary much. The types were presented by Dr. Sinclair, and were without locality; but there are others in the Museum labelled "Auckland."

VII. MELAMPSALTA MANGU, B. White.

*Melampsalta mangu*, Buchanan White, Ent. Mo. Mag., xv., p. 214 (1879).

This species is referred to *M. nervosa* by Mr. Distant; but I am not convinced of the identity of the two insects. Dr. White writes, "Four specimens from Mr. Wakefield, labelled 'On rocks at Porter's Pass, Canterbury, about 3,500ft.'" It may be identical with the following species, but I doubt it.

VIII. MELAMPSALTA CASSIOPE, Hudson.

*Cicada cassiope*, Hudson, Trans. N.Z. Inst., xxiii., p. 54 (1891).

Mr. Distant has referred this species to *M. nervosa*, under which name I have received a specimen from Mr. Hudson; it is, however, perfectly distinct. It is, however, probably identical with an insect noticed by Dr. Buchanan White at the end of his account of *M. mangu*: "I have another species much resembling *M. mangu*, but larger, and altogether black."

IX. Melampsalta iolanthe, Hudson.

*Cicada iolanthe*, Hudson, Trans. N.Z. Inst., xxiii., p. 53 (1891); Man. N.Z. Ins., p. 119, pl. 20, figs. 3, 3a, 3b (1892).

If this form is constant, it appears to be quite distinct from any of the foregoing species.

In addition to the foregoing species, Dr. Buchanan White enumerates *M. telxiope*, Walker (= *duplex*, Walker = *arche*, Walker). The types of *telxiope* and *duplex*, which appear to be synonymous, are from Australia, and I regard the bleached *C. arche* as certainly referable to *M. scutellaris*.

I cannot tell, without working out the great genus *Melampsalta*, which I have not time to undertake at present, whether any of the New Zealand species are identical with some of those described by Walker or others, under other names, from Australia, Tasmania, or unrecorded localities. Some of the New Zealand species appear to be very variable; and there must be many still undiscovered. It would be desirable for resident entomologists to try to obtain a series of the species occurring in different localities, in order to work out this small but interesting branch of the New Zealand fauna exhaustively.

From Australia (including Tasmania) about eighty *Cicadidæ* are at present recorded, belonging to the following genera:—

**Thopha*, Amyot (four species).
**Cyclochila*, Amyot (one species).
*Dundubia*, Amyot (one species).
**Henicopsaltria*, Stäl (two species).
**Macrotristria*, Stäl (one species).
*Chremistica*, Stäl (four species).
**Psaltoda*, Stäl (nine species).
*Huechys*, Amyot (one species).
*Tibicina*, Amyot (nine species).
*Abroma*, Stäl (two species).
**Cyrtosoma*, Westw. (two species).
**Chlorocysta*, Westw. (two species).
**Tettigareta*, White (two species).
*Melampsalta*, Amyot (thirty-seven species).

It is true that the cicad fauna of New Zealand is very much poorer than that of Australia, and that some of the genera above enumerated are tropical or subtropical forms; but both countries are very imperfectly explored at present—it can hardly be supposed that when Australia has fourteen genera—eight of which (indicated by an asterisk) are peculiar to the country—and eighty-three species, New Zealand has only one genus, represented by eight species in all. At any

rate, I expect to find several species of *Tibicina*, resembling *Melampsalta*, but with two separate nervures rising from the end of the basal cell, instead of one nervure bifurcating immediately, as in *Melampsalta*. If special attention is given to the subject by collectors, I have little doubt that several new species, and even genera, might easily be added to the New Zealand list.

## ART. XLIII.—*List of New Zealand Hydroida.*

By H. FARQUHAR.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

### GYMNOBLASTEA.

#### Clavidæ.

1. TUBICLAVA RUBRA.—*Tubiclava rubra*, Farquhar, 1895, Trans. N.Z. Inst., xxvii., 209.
*Hab.* Wellington Harbour.

2. CORDYLOPHORA, sp.—*Cordylophora lacustris*(?), Hamilton, 1883, N.Z. Jnl. of Sci., i., 419.
*Hab.* Esk River, Hawke's Bay.

#### Corynidæ.

3. CORYNE TENELLA.—*Coryne tenella*, Farquhar, 1895, Trans. N.Z. Inst., xxvii., 208.
*Hab.* Wellington Harbour.

#### Eudendridæ.

4. EUDENDRIUM NOVÆ-ZEALANDIÆ.—*Eudendrium novæ-zealandiæ*, Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 201.
*Hab.* Auckland.

#### Tubulariidæ.

5. TUBULARIA ATTENNOIDES.—*Tubularia attennoides*, Coughtrey, 1875, Trans. N.Z. Inst., viii., 302.
*Hab.* Dunedin Harbour; Ocean Beach.

### CALYPTOBLASTEA.

#### Campanulariidæ.

6. CAMPANULARIA CALICULATA, var. MAKROGONA.—*Campanularia integra*(?) (Hutton), Coughtrey, 1874, Trans. N.Z. Inst., vii., 291. *C. caliculata*, Coughtrey, 1875, *ib.*, viii.,

299; 1876, Ann. and Mag. Nat. Hist. (ser. 4), xvii., 25; v. Lendenfeld, 1885, Proc. Linn. Soc. N.S.W., ix., 910. *C. caliculata*, var. *makrogona*, v. Lendenfeld, 1885, *ib.*, ix., 922; Bale, 1888, *ib.* (ser. 2), iii., 755.

*Hab.* Port Chalmers; Taiaroa Head; Wellington Harbour; Australia.

7. CAMPANULARIA BILABIATA.—*Campanularia bilabiata*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 291; 1875, *ib.*, viii., 299.

*Hab.* Timaru.

8. CAMPANULARIA CARDUELLA.—*Campanularia carduella*, Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 132.

*Hab.* N.Z.*

9. CAMPANULARIA FRUTICOSA.—*Laomedia fruticosa*, Esper, 1830, Pflan. Abb. nach der Natur mit Faben erleuchtet (8), xxxiv., 162. *Sertularella fruticosa*, Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 100. *Campanularia fruticosa*, Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 205.

*Hab.* N.Z.; Philippine Islands; Ceylon.

10. OBELIA GENICULATA.—*Obelia geniculata*, Linnæus, 1767, Syst. Nat., i., 1312; Hincks, 1868, Hist. Brit. Hyd. Zooph., 149; Coughtrey, 1875, Trans. N.Z. Inst., viii., 299; 1876, Ann. and Mag. Nat. Hist. (ser. 4), xvii., 24; Bale, 1884, Cat. Aust. Hyd. Zooph., 59; 1894, Proc. Roy. Soc. Vict. (new. ser.), vi., 99; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 208. *Laomedea geniculata*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 290.

*Hab.* Wellington Harbour; Cook Strait; south and east coasts of South Island; Australia; Europe; east coast North America.

11. OBELIA (?) PYGMÆA.—*Obelia pygmæa*, Coughtrey, 1876, Ann. and Mag. Nat. Hist. (ser. 4), xvii., 25.

*Hab.* Dunedin (?).

12. OBELIA AUSTRALIS.—*Obelia australis*, v. Lendenfeld, 1885, Proc. Linn. Soc. N.S.W., ix., 604, 920; Bale, 1888, *ib.* (ser. 2), iii., 753.

*Hab.* East Coast.

13. HEBELLA SCANDENS.—*Lafoëa scandens*, Bale, 1888, Proc. Linn. Soc. N.S.W. (ser. 2), iii., 758. *Hebella scandens*, Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 214.

*Hab.* Auckland; Australia.

* N.Z. denotes that the species has not been recorded from any definite locality.

14. CLYTIA (?) ELONGATA.—*Clytia* (?) *elongata*, Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 215.
*Hab.* Auckland.

15. EUCOPE ANNULATA.—*Eucope annulata*, v. Lendenfeld, 1885, Proc. Linn. Soc. N.S.W., ix., 602.
*Hab.* Auckland.

### Perisiphoniidæ.

16. LAFOËA CYLINDRICA.—*Lafoëa cylindrica*, v. Lendenfeld, 1885, Proc. Linn. Soc. N.S.W., ix., 912.
*Hab.* Bay of Islands.

17. LAFOËA DUMOSA (?).—*Lafoëa dumosa* (?), Coughtrey, 1875, Trans. N.Z. Inst., viii., 299.
*Hab.* Otago Peninsula.

18. CRYPTOLARIA GRACILIS.—*Cryptolaria gracilis*, Allman, 1888, "Challenger" Report, xxiii., Hydroida, 42.
*Hab.* Off the East Cape, 700 fathoms.

19. PERISIPHONIA PECTINATA.—*Perisiphonia pectinata*, Allman, 1888, "Challenger" Report, xxiii., Hydroida, 45.
*Hab.* Off the East Cape, 700 fathoms.

### Haleciidæ.

20. HALECIUM DELICATULA.—*Halecium delicatula*, Coughtrey, 1875, Trans. N.Z. Inst., viii., 299; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 26.
*Hab.* Dunedin Harbour.

21. HALECIUM PARVULUM.—*Halecium parvulum*, Bale, 1888, Proc. Linn. Soc. N.S.W. (ser. 2), iii., 760; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 218.
*Hab.* Auckland; Australia.

### Sertulariidæ.

22. SERTULARIA ELONGATA.—*Sertularia elongata*, Lamouroux, 1816, Hist. Polyp. Flex., 189; Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 107; Bale, 1884, Cat. Aust. Hyd. Zooph., 75; 1888, Proc. Linn. Soc. N.S.W. (ser. 2), iii., 770; Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 140; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 220. *Dynamene abietinoides*, Gray, 1843, Dieffenbach's "New Zealand," ii., 294. *Sertularia abietinoides*, Hutton, 1872, Trans. N.Z. Inst., v., 257; Coughtrey, 1874, *ib.*, vii., 285; 1875, *ib.*, viii., 300; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 28.
*Hab.* Lyall Bay; Australia; Tasmania.

23. SERTULARIA BISPINOSA.—*Dynamene bispinosa*, Gray, 1843, Dieffenbach's "New Zealand," ii., 294. *Sertularia bispinosa*, Hutton, 1872, Trans. N.Z. Inst., v., 257; Coughtrey, 1874, *ib.*, vii., 284; 1875, *ib.*, viii., 300; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 27; Bale, 1884, Cat. Aust. Hyd. Zooph., 67; 1887, Trans. Roy. Soc. Vict., xxiii., 92; 1888, Proc. Linn. Soc. N.S.W. (2), iii., 745; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 229. *Sertularia operculata* (?), Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 106. *Diphasia symmetrica*, v. Lendenfeld, 1884, Proc. Linn. Soc. N.S.W., ix., 414.
*Hab.* Lyall Bay; Auckland; Australia; Indian Ocean.

24. SERTULARIA CRINIS.—*Sertularia crinis*, Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 139.
*Hab.* Tauranga.

25. SERTULARIA TRISPINOSA.—*Sertularia trispinosa*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 284; 1875, *ib.*, viii., 300; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 28; Bale, 1884, Cat. Aust. Hyd. Zooph., 69; 1883, Proc. Roy. Soc. Vict., xxiii., 92.
*Hab.* N.Z.; Australia.

26. SERTULARIA RAMULOSA.—*Sertularia ramulosa*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 283; 1875, *ib.*, viii., 300; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 28.
*Hab.* Dunedin Harbour; Bluff Harbour; Timaru.

27. SERTULARIA OPERCULATA.—*Sertularia operculata*, Linnæus, 1767, Syst. Nat., i., 1307; Busk, 1852, Macgillivray's Voyage of the "Rattlesnake," i., 387; Hincks, 1868, Brit. Hyd. Zooph., 263; Bale, 1882, Jnl. Mic. Soc. Vict., ii., 44; 1884, Cat. Aust. Hyd. Zooph., 67; Allman, 1888, "Challenger" Report, xxiii., Hydroida, 61; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 231.
*Hab.* N.Z.; Auckland Islands; Australia; Kerguelen; Patagonia; Falkland Islands; South Africa; Europe.

28. SERTULARIA MINIMA.—*Synthecium gracilis*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 286. *Sertularia pumila*, Coughtrey, 1875, Trans. N.Z. Inst., viii., 301; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 29. *Sertularia minima*, Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 104; Bale, 1884, Cat. Aust. Hyd. Zooph., 89; 1887, Proc. Roy. Soc. Vict., xxiii., 109; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 231; Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 138. *Sertularia pumiloides*, Bale, 1882, Jnl. Mic. Soc. Vict., ii., 21, 45.
*Hab.* Timaru; Dunedin; Australia; Cape of Good Hope.

29. SERTULARIA UNGUICULATA.—*Sertularia unguiculata*, Busk, 1852, Voy. of the "Rattlesnake," i., 394; Bale, 1882, Jnl. Mic. Soc. Vict., ii., 45; 1884, Cat. Aust. Hyd. Zooph., 76; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 231; Bale, 1894, Proc. Roy. Soc. Vict., vi. (new ser.), 100. *Sertularia* sp., Coughtrey, 1876, Ann. and Mag. Nat. Hist. (4), xvii., 29, note. *Thuiaria ambigua*, Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 111. *Desmoscyphus unguiculata*, Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 144.
*Hab.* Bluff Harbour; Australia.

30. SERTULARIA SIMPLEX.—*Sertularia simplex*, v. Lendenfeld, 1885, Proc. Linn. Soc. N.S.W., ix., 913, 984.
*Hab.* Lyttelton.

31. SERTULARIA HUTTONI.—*Sertularia huttoni*, Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 233.
*Hab.* N.Z.

32. SERTULARIA UNILATERALIS.—*Sertularia unilateralis*, Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 139.
*Hab.* N.Z.; Australia.

33. SERTULARELLA JOHNSTONI.—*Sertularia johnstoni*, Gray, 1843, Dieffenbach's "New Zealand," ii., 294; Hutton, 1872, Trans. N.Z. Inst., v., 256; Coughtrey, 1874, *ib.*, vii., 281. *Sertularia subpinnata* and *S. delicatula*, Hutton, 1872, Trans. N.Z. Inst., v., 256. *Sertularella johnstoni*, Coughtrey, 1875, Trans. N.Z. Inst., viii., 299; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 26; Thompson, 1879, Ann. and Mag. Nat Hist. (5), iii., 101; Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 261; Bale, 1884, Cat. Aust. Hyd. Zooph., 109; 1887, Proc. Roy. Soc. Vict., xxiii., 93; 1894, *ib.*, vi. (new ser.), 102. *Sertularella purpurea*, Kirchenpauer, 1884, Abh. des Natur., viii.
*Hab.* Lyall Bay; east and west coasts of the South Island; Chatham Islands; Australia; Tasmania.

34. SERTULARELLA CAPILLARIS.—*Sertularella capillaris*, Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 138.
*Hab.* N.Z.

35. SERTULARELLA POLYZONIAS.—*Sertularia polyzonias*, Linnæus, 1767, Syst. Nat., i., 1312. *Sertularella polyzonias*, Hincks, 1868, Hist. Brit. Hyd. Zooph., 235; Bale, 1884, Cat. Aust. Hyd. Zooph., 104; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 224; Allman, 1879, Trans. Roy. Soc., clxviii., 282. *Sertularia simplex*, Hutton, 1872, Trans. N.Z. Inst., v., 257; Coughtrey, 1874, *ib.*, vii., 283; 1875, *ib.*, viii., 300. *Sertularella simplex*, Cough-

trey, 1876, Ann. and Mag. Nat. Hist. (4), xvii., 27. *Sertularella kerguelensis*, Allman, 1876, Ann. and Mag. Nat. Hist. (4), xvii., 113.

*Hab.* Lyall Bay; Timaru; Dunedin; Australia; Kerguelen; South Africa; Falkland Islands; Europe; North America.

36. SERTULARELLA ROBUSTA.—*Sertularella robusta*, Coughtrey, 1875, Trans. N.Z. Inst., viii., 300; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 27.

*Hab.* Dunedin; Foveaux Strait.

37. SERTULARELLA PYGMÆA.—*Sertularella pygmæa*, Bale, 1882, Jnl. Mic. Soc. Vict., ii., 25; 1884, Cat. Aust. Hyd. Zooph., 108.

*Hab.* N.Z.; Australia.

38. SERTULARELLA RAMOSA.—*Sertularella ramosa*, Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 102; Bale, 1884, Cat. Aust. Hyd. Zooph., 111.

*Hab.* N.Z.; Australia (?).

39. SERTULARELLA EXIGUA.—*Sertularella exigua*, Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 101.

*Hab.* N.Z.

40. SERTULARELLA INTEGRA.—*Sertularella integra*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 262.

*Hab.* N.Z.

41. SERTULARELLA MUELLERI.—*Sertularella muelleri*, Kirchenpauer, 1884, Abh. des Natur. ver., Hamb., viii., 49; Lendenfeld, 1885, Proc. Linn. Soc. N.S.W., x., 478.

*Hab.* Chatham Islands.

42. SERTULARELLA EPISCOPUS.—*Sertularia fusiformis*, Hutton, 1872, Trans. N.Z. Inst., v., 257; Coughtrey, 1874, *ib.*, vii., 285. *Sertularella episcopus*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 263. *Sertularia longicosta*, Coughtrey, 1875, Trans. N.Z. Inst., viii., 300; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 28.

*Hab.* Lyall Bay.

43. THUIARIA ZELANDICA.*—*Thuiaria zelandica*, Gray, 1843, Dieffenbach's "New Zealand," ii., 214; Hutton, 1872, Trans. N.Z. Inst., v., 258; Coughtrey, 1874, *ib.*, vii., 288; Quelch, 1883, Ann. and Mag. Nat. Hist. (5), xi., 247. *Thuiaria dolichocarpa*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 270; Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 110; Bale, 1887, Proc. Roy. Soc. Vict., xxiii., 108.

*Hab.* Hokianga.

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* I cannot agree with Mr. Bale that the law of priority should be set aside in this case.

44. THUIARIA MONILIFERA.—*Sertularia monilifera*, Hutton, 1872, Trans. N.Z. Inst., v., 257; Coughtrey, 1874, *ib.*, vii., 282; 1875, *ib.*, viii., 301; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 30. *Thuiaria cerastium*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 271. *Thuiaria monilifera*, Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 111.
*Hab.* Hokianga; Lyall Bay.

45. THUIARIA SUBARTICULATA.—*Thuiaria articulata*, Hutton, 1872, Trans. N.Z. Inst., v., 258. *Thuiaria subarticulata*, Coughtrey, 1874, *ib.*, vii., 287; 1875, *ib.*, viii., 301; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 30; Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 110; Bale, 1888, Proc. Linn. Soc. N.S.W. (ser. 2), iii., 746. *Thuiaria bidens*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 269. *Sertularia fertilis*, Lendenfeld, 1884, Proc. Linn. Soc. N.S.W., ix., 406.
*Hab.* Lyall Bay; Oamaru; Timaru.

46. THUIARIA QUADRIDENS.—*Thuiaria quadridens*, Bale, 1884, Cat. Aust. Hyd. Zooph., 119; Lendenfeld, 1885, Proc. Linn. Soc. N.S.W., ix., 915.
*Hab.* Timaru; Australia.

47. SELAGINOPSIS NOVÆ-ZELANDIÆ.—*Pericladium novæ-zelandiæ*, Thompson, 1879, Ann. and Mag. Nat. Hist. (5), iii., 112. *Selaginopsis novæ-zelandiæ*, Thompson, *loc. cit.*, p. 113 (note).
*Hab.* Pandora Bank.

48. DESMOSCYPHUS BUSKII.—*Desmoscyphus buskii*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 265.
*Hab.* N.Z.

49. HYDRALLMANIA BICALYCULA.—*Hydrallmania* (?) *bicalycula*, Coughtrey, 1875, Trans. N.Z. Inst., viii., 301; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 29.
*Hab.* Bluff Harbour; Wickliff Bay.

## Synthecidæ.

50. SYNTHECIUM ELEGANS.—*Synthecium elegans*, Allman, 1870, Gymno. and Tub. Hyd., ii., 229; 1876, Jnl. Linn. Soc. (Zool.), xii., 266; Coughtrey, 1874, Trans. N.Z. Inst., vii., 285. *Sertularia elegans*, Coughtrey, 1875, *ib.*, viii., 301; 1876, Ann. and Mag. Nat. Hist. (4), xvii., 29.
*Hab.* Bluff Harbour.

51. SYNTHECIUM RAMOSUM.—*Synthecium ramosum*, Allman 1885, Jnl. Linn. Soc. (Zool.), xix., 137.
*Hab.* Tauranga.

52. SYNTHECIUM CAMPYLOCARPUM. — *Synthecium campylocarpum*, Allman, 1888, "Challenger" Report (Zool.), xxiii., Hydroida, 78; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 248.
*Hab.* Auckland.

## Plumulariidæ.

53. PLUMULARIA SETACEA.—*Corallina setacea*, Ellis, 1755, Corall., pl. xxxviii., fig. 4. *Plumularia setacea*, Hincks, 1868, Hist. Brit. Hyd. Zooph., 296; Bale, 1888, Proc. Linn. Soc. N.S.W. (ser. 2), iii., 778. *Plumularia tripartita*, Lendenfeld, 1884, Proc. Linn. Soc. N.S.W., ix., 477.
*Hab.* Timaru; Australia; Europe.

54. PLUMULARIA SPINULOSA. — *Plumularia spinulosa*, Bale, 1882, Jnl. Mic. Soc. Vict., ii., 42; 1884, Cat. Aust. Hyd. Zooph., 139; Lendenfeld, 1884, Proc. Linn. Soc. N.S.W., ix., 475.
*Hab.* Timaru; Australia.

55. PLUMULARIA TURGIDA.—*Plumularia turgida*, Bale, 1888, Proc. Linn. Soc. N.S.W. (ser. 2), iii., 779.
*Hab.* Lyttelton.

56. PLUMULARIA CAMPANULA.—*Plumularia campanula*, Busk, 1852, Voy. of the "Rattlesnake," pl. x., fig. 5; Bale, 1884, Cat. Aust. Hyd. Zooph., 124; 1894, Proc. Roy. Soc. Vict. (new ser.), vi., 113; 1890, Marktanner-Turneretscher, Annal. des k. k. Natur. Hofm., v., 255. *Plumularia indivisa*, Bale, 1882, Jnl. Mic. Soc. Vict., ii., 39. *Plumularia rubra*, Lendenfeld, 1884, Proc. Linn. Soc. N.S.W., ix., 476; Bale, 1888, *ib.* (ser. 2), iii., 778.
*Hab.* Auckland; Australia.

57. PLUMULARIA MULTINODA.—*Plumularia multinoda*, Allman, 1885, Jnl. Linn. Soc. (Zool.), xix., 157.
*Hab.* Tauranga.

58. PLUMULARIA (?) SIMPLEX.—*Plumularia simplex*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 290. *Plumularia* (?) *simplex*, Coughtrey, 1874, *ib.*, viii., 301; 1874, Ann. and Mag. Nat. Hist. (4), xvii., 81.
*Hab.* Ocean Beach, Dunedin.

59. ANTENNULARIA ANTENNINA.—*Sertularia antennina*, Linnæus, 1767, Syst. Nat., 1310. *Antennularia antennina*, Hincks, 1868, Hist. Brit. Hyd. Zooph., 280; Hutton, 1872, Trans. N.Z. Inst., v., 258; Coughtrey, 1874, *ib.*, vii., 288; 1876, Ann. and Mag. Nat. Hist. (4), xvii. 81.
*Hab.* Lyall Bay; Europe.

## Aglaopheniidæ.

60. AGLAOPHENIA INCISA.—*Plumularia incisa*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 290. *Aglaophenia incisa*, Coughtrey, 1876, Ann. and Mag. Nat. Hist. (4), xvii., 38.
*Hab.* Lyall Bay.

61. AGLAOPHENIA BANKSII.—*Plumularia banksii*, Gray, 1843, Dieffenbach's "New Zealand," ii., 294; Coughtrey, 1874, Trans. N.Z. Inst., vii., 289. *Aglaophenia banksii*, Bale, 1887, Proc. Roy. Soc. Vict., xxiii., 103.
*Hab.* N.Z.

62. AGLAOPHENIA HUTTONI.* — *Plumularia banksii*, Hutton, 1872, Trans. N.Z. Inst., v., 259. *Plumularia huttoni*, Coughtrey, 1874, Trans. N.Z. Inst., vii., 290. *Aglaophenia huttoni*, Coughtrey, 1876, Ann. and Mag. Nat. Hist. (4), xvii., 31.
*Hab.* Lyall Bay.

63. AGLAOPHENIA ACANTHOCARPA.—*Aglaophenia acanthocarpa*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 274.
*Hab.* N.Z.

64. AGLAOPHENIA LAXA. — *Aglaophenia laxa*, Allman, 1876, Jnl. Linn. Soc. (Zool.), xii., 275.
*Hab.* N.Z.

65. AGLAOPHENIA FORMOSA.—*Plumularia formosa*, Busk, 1850, Brit. Ass. Rep. *Aglaophenia formosa*, Kirchenpauer, 1872, Abh. der Natur., ver. Hamb., v., 26; Bale, 1884, Cat. Aust. Hyd. Zooph., 168; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 264.
*Hab.* N.Z.; Australia; South Africa.

## Idiiæ.

66. IDIA PRISTIS.—*Idia pristis*, Lamouroux, 1816, Hist. Polyp. Flex., 200; Busk, 1852, Voy. of the "Rattlesnake," i., 389; Allman, 1883, "Challenger" Report, vii., 85; Lendenfeld, 1884, Proc. Linn. Soc. N.S.W., ix., 419; Bale, 1884, Cat. Aust. Hyd. Zooph., 113; 1888, Proc. Linn. Soc. N.S.W. (ser. 2), iii., 748; 1894, Proc. Roy. Soc. Vict. (new ser.), vi., 104; Marktanner-Turneretscher, 1890, Annal. des k. k. Natur. Hofm., v., 280. *Diphasia rectangularis*, Lendenfeld, 1884, Proc. Linn. Soc. N.S.W., ix., 914.

* There are two species named *Aglaophenia huttoni*: *A. huttoni*, Coughtrey (see above), and *A. huttoni*, Kirchenpauer = *Plumularia pennatula*, Hutton, 1872, Trans. N.Z. Inst., v., 258; Coughtrey, 1874, *ib.*, vii., 289; *A. pennatula* (?), Coughtrey, 1876, Ann. and Mag. Nat. Hist. (4), xvii., 31. They are both given by Mr. Bale in a list of species which were over-looked by Von Lendenfeld, Proc. Roy. Soc. Vict., xxiii., 108. Unfortunately I have not seen Kirchenpauer's paper, and I cannot say which has priority and which must be changed.

*Hab.* Many parts of New Zealand coast (v.L.); Australia; Singapore.

ELEUTHEROBLASTEA.

**Hydridæ.**

67. HYDRA VIRIDIS.—*Hydra viridis*, Linnæus, 1767, Syst. Nat., 1320; Hincks, 1868, Hist. Brit. Hyd. Zooph., 312; Coughtrey, 1876, Ann. and Mag. Nat. Hist. (4), xvii., 24.

*Hab.* Ponds near Dunedin.

## ART. XLIV.—*On the Habits of New Zealand Ants.*

By W. W. SMITH, F.E.S.

[*Read before the Philosophical Institute of Canterbury, 2nd October, 1895.*]

AT the present time the number of endemic ants described by F. Smith, Mayr, Hutton, Forel, and Emery comprise nineteen species, representing three sub-families, included in nine genera and three sub-genera. Professor Forel, in his recent classification, has carefully corrected the nomenclature and generic arrangement of the New Zealand *Formicidæ*. This is a valuable service to students of the native ants, while his masterly definitions of their specific characters should be a safe guide to them when describing new species or varieties. Professor Emery has also lately described and figured* a new species (*Discothyrea antarctica*) from New Zealand, and removed *Orectognathus perplexus*, Sm., to the genus *Strumigenys*, which species now remains as *S. perplexa*, Sm. It is highly satisfactory to have our interesting native ants described and classified by those eminent specialists on *Formicidæ*.

Professor Emery's observations on the occurrence of *Discothyrea antarctica* in New Zealand as a case illustrating the "cosmopolitanism and great antiquity" of most genera of the *Gonerinæ* are equally applicable to several other genera occurring at the Antipodes. The genus *Huberia* of Forel is represented at present by two species: *H. striata*, Sm., the largest native ant, occurs in large and small communities distributed over both Islands; *H. brouni*, Forel, was discovered by Captain Broun at Rotorua, but has not as yet

* Trans. N.Z. Inst., vol. xxvii., p. 636.

been observed in the South Island. Forel's new var. *Striata rufescens* was collected by Mr. A. T. Urquhart on Pirongia Mountain. *Prolascus advena*, Sm., occurs in large communities in both Islands. *Ponera castanea*, Mayr; *Acanthoponera brounii*, Forel; *Amblyopone cephalotis*, Sm.; *A. saundersi*, Forel; *Orectognathus antennatus*, Sm.; *Ponera antipodum*, Forel; *Strumigenys perplexa*, Sm.; and *Discothyrea antarctica*, Emery, have recently been collected by Captain Broun at Drury, Mercury Bay, and Rotorua, but are unknown at present in the South Island. The genus *Monomorium* is represented by five species, two of which are found in both Islands. *M. integrum*, *M. suteri*, and *M. smithii*, discovered three years ago at Ashburton, will probably also be found to inhabit the North Island. Before dealing with the habits of endemic ants and their economic and parasitic attendants, I may state that my observations apply only to the species occurring in Canterbury.

As the habits of European ants have been so exhaustively treated by Huber, White, Forel, and Lubbock, it would be superfluous to enter minutely into details of the habits of the native *Formicidæ*. There is practically so little difference in the relative habits of the European and Antipodean species of ants of the same genus that it will only be necessary to record the more striking or characteristic features of the latter. The five species of *Monomorium* all occur commonly in large and small communities, under variously-sized stones on the Canterbury Plains. Perhaps no country can show so many species of the same genus inhabiting separate nests within so small a radius. In addition to the nests of *Huberia striata*, the five distinct forms of *Monomoria* are frequently situated within a few yards of each other. The greater number of and more populous nests of *Monomoria* are found under stones half embedded in sandy situations supporting a stunted vegetation, such as we find on old river-beds and the stony upper parts of the Plains. There are several causes which apparently guide the ants in selecting these sites. The network of roots generally growing beneath the cool, damp undersides of the stones supports several species of root-feeding Coccids, which are unquestionably of considerable economic value to ants. The removal of the loose sand or poor sandy soil from under the stones is also more easily accomplished by the ants when forming courts and tunnels than where stones are imbedded in deep, rich soil. We have occasionally found nests of *M. nitidum* under stones imbedded in coarse shingle where no plants grew, and which contained no Coccids or other insects—at least, so far as we could detect without molesting the whole of the nests. On the 19th November and 12th December last we examined two of these

nests for the purpose of collecting all insects, &c., we could find associating with the ants. In both nests we found none. Both were large communities, each numbering about eight hundred individuals. We found vast numbers of eggs and larvæ in the interstices of the stones at a depth of 15in. and 16in. from the surface. In one we obtained ten queens secreted in different parts of the nest, some in cool, moist chambers 17in. down in the shingle. Excepting some fragments of the elytra of minute beetles and wings of flies, we could not detect any other remnants of their food. We, however, have found large and small colonies situated among stunted vegetation containing considerable numbers of Coccids, some minute parasitic beetles (*Diarthrocera formiciphila*, Broun), and an Acarian (*Leiosoma longipilis*, Moniez). Notwithstanding the closest search in the nests of all the *Monomoria*, we have observed the beetles present only in the colonies of *M. nitidum* and *M. suteri*. *M. nitidum* is the most active native ant, and vigorously assails all intruders near its nest.

*Huberia striata*, Smith, is the largest endemic ant. Although it exists in fair-sized colonies on the old river-beds on the Plains, the largest are met with in limestone districts, or in warm rocky valleys near the main range. At Albury immense colonies exist beneath detached pieces of limestone lying among the tussock at the base of the whole length of the sloping bed of *débris* beneath the great rocks. Owing to the vast numbers of ants in the nests it was frequently difficult to examine their structure or collect the economic or other insects found associating with them. In many of the nests I found considerable numbers of the pretty little shell *Laoma haasti*, Hutton, lying in the courts and tracks of the ants. Some were bleached, and all were empty; but whether they had crept into the nests or been carried there by the ants I am unable to say. The mollusc is extremely common among the broken rocks, and I am inclined to believe that they were carried into the nests by the ants for food. I rarely found them under stones where there were no ants, and these were generally alive. One important fact which serves to illustrate the effect of situation on the economy of ants is that we never observed Coccids in their nests in the neighbourhood of the rocks. The latter is covered in parts with low vegetation, and generally teems with insect-life, especially beetles, whose elytra we found in quantities in the ants' nests. At Ashburton and on many parts of the Plains this fine ant exists in smaller colonies, and is almost invariably found associating with a large yellow subterranean Coccid (*Dactylopius arecæ*, Maskell). The latter is a root-feeder, and occurs plentifully on the roots of *Pimelea*, *Carmichælia*, *Discaria*,

*Acæna microphylla*, and many other plants growing in poor situations. In the bottoms of some of the valleys of the Gawler Downs, Mount Somers, I have met with very large colonies under stones lying among the mixed vegetation. On the roots of *Pimelea*, *Poa*, and other plants were groups of a large slate-coloured form of *Dactylopius poæ*, Maskell. They were firmly attached to the roots, and did not appear to be molested by the ants. In order to test their relations I carefully detached a few and dropped them in the midst of the throng of excited ants. They were instantly seized by workers and carried into the dark galleries. On one occasion we noticed some extremely minute transparent-winged flies rise from the underside of the stone when turned over. The nest contained over sixty adult females of *D. poæ*, and possibly these minute flies were the males of this Coccid.

The presence of certain plants in some localities explains the presence of ants' nests near them. The roots of *Acæna microphylla* are particularly liable to the attacks of *D. arecæ*, and a species of root-feeding white woolly Aphis. Both insects are a great attraction to this ant, which forms clear passages alongside the Aphis- and Coccid-infested roots. These tracks are frequently traversed by the ants who attend on and obtain food from these rhizophagous insects. I have occasionally observed the ants moving leisurely over the Aphis and Coccids, gently stroking them with their antennæ, and moving their woolly and cottony secretions. The latter when freshly secreted unquestionably contains a sweetish moisture, which attracts the ants, and is much relished by them. The three economic insects alluded to above are the only species we have observed in the nests of, or being attended by, this fine ant. It is an enchanting scene in ant-life to gently turn over a large stone and look into a populous colony of *H. striata*. From September to January the courts and galleries of the nests contain groups of eggs and larvæ of different ages. When the light and air is admitted the eggs and larvæ are rapidly seized by the workers and borne away to places of safety in the inner galleries of the nest. The queens are very timid, and disappear into their chambers immediately the stone is raised. When examining the structure of the galleries we have occasionally found it difficult to trace the queens to their hiding-places in the nest. The galleries generally ramify in many directions, and often to considerable depths, especially when the site of the nest is on stony ground. I have observed young winged queens, males, and neuters of *H. striata* appearing earlier in their nests than in the nests of all other species occurring in Canterbury. They begin to appear about the 10th November, and continue to add to their number until they swarm in February. A calm, sultry day is chosen for

this great event in ant-life. If viewed in the sunshine a few days before swarming, the throng of busy ants with glistening wings presents a charming picture of social life among insects. Huber describes the attention bestowed by the neuters of some European ants on young queens during their development. In large colonies of *H. striata* it is a common occurrence to find queens in course of transforming lying in the common tracks and courts of the nests. I have frequently observed the males and workers run over and pass them by unnoticed, especially in the pupal stage. Whether the care of young queens is allotted to particular individuals I am unable to say. I have, however, seen a large worker seize the pupæ and carry them into one gallery. In the nest in question three pupal queens lay in different parts of courts. When the worker seized the first pupa I touched it gently with red ink to enable us to clearly observe its movements among the host of ants. After an absence in the gallery of two minutes it appeared, walked rapidly along the track where the pupal queen lay, then turned almost at a right angle along another track for about 5in., seized another young pupal queen and took the same track back into the gallery where it placed the first. In two minutes more it again appeared, and, taking the one track, passed the entrance on the right where it picked up the second pupa, and, proceeding along another track to the right, seized a third pupal queen and bore it away with the clearest deliberation into the same gallery where the previous two were taken. The question of the allotment of labour among ants is one often discussed. The preservation of their young is an instinct common to the workers of all social ants. In communities of ants, like those of the higher groups of animals, more intelligent individuals will often occur. The removal of these young queens by the single individual showed very clearly its own undoubted intelligence and instinct for their preservation. In all probability the same ant had previously placed them in the tracks where they lay when we raised the stone. The case further illustrates the reasoning sentient powers of social ants. Huber cites a case of several workers being employed constructing a portion of a new nest. A single ant approached them and communicated his thoughts, whereupon the work done was pulled down and reconstructed on a better plan. The instinct of the preservation of their young exists in the minds of ants apart from their many intelligent habits which are unquestionably acquired during their existence. The following case, which occurred with a nest of *Huberia striata*, is another case in point. On 2nd November, 1892, Mr. T. Sealy, of Tinwald, informed me that he had seen a number of ants busy removing eggs from their nest, situated under stones on

the Ashburton River-bed. We visited the place on the 4th, and found the ants inhabiting much higher ground than when Mr. Sealy observed them migrating two days previously. The object of removing the eggs was perfectly clear. The river had been slowly rising for several days before Mr. Sealy noticed them removing their eggs, and the water had penetrated the coarse shingle to within a few inches of the old site of the nest the day we examined it. It is worthy of note that our native ants, although long isolated from other regions, are in no sense inferior in intelligence to those existing in other countries. Too much stress is laid on instinct by writers in guiding the habits of social insects.

*Monomorium antarcticum*, White ( = *M. fulvum*, Mayr), occurs plentifully in both Islands. I have met with large communities of this ant under stones in open situations in Westland. They, however, exist in larger communities on the eastern side of the Alps, especially on the outskirts of the bush, and in warm valleys of the lower hills bounding the Plains. Like *H. striata*, they haunt the habitats of subterranean Coccids, and may frequently be seen gently stroking them with their antennæ. I have frequently observed workers seize large females of *D. poæ* and remove them to places of safety. When studying the habits of ants it is important to gently raise the stones covering their nests. By doing so an excellent glimpse of the natural conditions of the nests is obtained. If this is practised on a calm, dull day the ants do not so readily become excited as they do on sunny or windy days. In some of the nests where Coccids were numerous we noticed the ants for a few seconds removing the soft cottony secretion from them. It is a common occurrence to see many of the ants moving about the nest with minute particles of the fine cottony substance adhering to their heads and mandibles. Where Coccid- (*D. arecæ*) and Aphis-infested roots of *Acæna microphylla* are found in patches on the Ashburton River-bed they are attended by this ant, who treat these parasitic insects with care, gently stroking them with the antennæ, and manipulating the cottony secretions with the mandibles. My friend Mr. A. Brooks informs me that this species occurs in the bush at Danevirke in very large communities. Excepting the brighter colours of the specimens sent to me from Danevirke there is no other feature to distinguish them from specimens collected on the Plains. In the Mount Somers district this ant is found in the autumn in greater numbers in spiderwebs than other species of *Monomoria*, and the same fact is recorded by Mr. G. V. Hudson from the Wellington District.

*M. nitidum*, Smith: In addition to the foregoing remarks on this interesting ant I have to refer to some curious Coc-

cids, Acarians, Thysanura, and Coleoptera occurring in their nests. Mr. Maskell has described and figured* *Ripersia formicicola*, and made some suggestive remarks on this Coccid in relation to ants. On this question he stated that "There appears to be a general consensus of opinion that Aphides are made use of by ants for their honey-dew, or, as frequently stated, employed as 'milch-cows'; but this is the first instance that I know of where ants and Coccids dwell together, and the quantity of honey-dew secreted by the *Ripersia* cannot be very great. . . . It would be interesting to know whether in other countries Coccids are found under similar conditions, and, if so, how the ants and they mutually behave to each other." These very suggestive remarks on the mutual relations of ants and Coccids dwelling amicably together has created a general interest among students of the *Coccidæ*. There has lately been an earnest and extensive search made for Coccids in the nests of British and Continental ants, with the result that another new species (*Ripersia tomlini*, Newstead) was discovered by Miss Tomlin in an ant's nest in the Island of Jersey. Other new species belonging to different genera have also been discovered associating with ants in England, and have lately been described by Mr. Newstead. When the first specimens were sent to Mr. Maskell we had not previously examined the ants' nests to ascertain the possible number of *Ripersiæ* in each. Since reading Mr. Maskell's paper, three years ago, we have made a minute and prolonged search for *Ripersiæ* in the nests of all the known *Monomoria*. On first turning over a stone covering a nest we have observed from three to thirty-two *Ripersiæ* inhabiting the tracks and courts. When air and light is admitted into the nest these minute insects begin to move about, seeking concealment. When they are not seized and carried away by the ants they will occasionally walk unassisted into the galleries. They are frequently found moving about on the under-surface of the stone covering the nest. We have often raised the stone off the nest and witnessed the ants along with the Coccids seize the latter and carry them about for several minutes all over its surface. We have laid the stone down and allowed the ants to escape, when they generally went in a direct line for the nest and carried the Coccids into the galleries.

In a paper "On the Origin of Ants' Nests"† I have discussed the question of the presence of numerous Coccids under stones as frequently forming the basis of ants' nests. In referring to several points I wrote, "I have mentioned the presence of Aphides and Coccids feeding on the roots

* Trans. N.Z. Inst., vol. xxiv., p. 38.

† *Entomologists' Monthly Magazine*, second series, vol. iii., p. 60.

beneath the boulders as forming an economic basis for the origin of the ants' nests. The cool damp undersides of the boulders naturally draw the roots of plants and attract their parasites to them, while at the same time they afford the requisite conditions for establishing young communities of the ants. The latter instinctively search for these sites, and while thus engaged several of the sexes meet and associate together to form new nests. Beneath some of the stones we have often observed where they had only commenced to excavate their galleries, and we have seen others in course of progress—from the most rudimentary to the highly-finished and numerous galleries in the nests of the old and flourishing communities. When the work of excavating the galleries has commenced the ants do not readily desert the site, and they bestow great care on the domestic or economic inhabitants of their nests." These remarks applied chiefly to *M. nitidum*; and, although I mention having examined two nests situated in rough shingle which contained no Coccids, they are, as a rule, applicable to the origin of the nests of this species. We have counted eighty-four Coccids (*R. formicicola*) with a single colony, and probably we missed many more when digging up the shingly site of the nest. After a patient search for several years among hundreds of nests we have not discovered this peculiar Coccid elsewhere than in ants' nests. The curious beetle *Diarthrocera formiciphila*, Broun, we observed in the imago state associating with ants.

Professor R. Moniez has lately described and figured an Acarian (*Leiosoma longipilus*) and two Thysanura (*Drepanura brachycephala* and *Lipura incerta*) found associating with *Monomoria* in New Zealand. Two more species (*Entomobrya multifasciata*, Tullb., and *Achoratis armatus*, Nic., Tullb.) were also among the insects sent to Professor Moniez. These latter species he considers occur accidentally in ants' nests.

*M. suteri*, Forel, is a somewhat smaller ant than *M. nitidum*, but of very similar habits. Large and small communities of this glossy-black species exist under boulders on the Ashburton River-bed. Like the preceding species, they haunt and protect colonies of Coccids parasitic on the roots of several plants. *R. formicicola* occurs abundantly in their nests, the white, cottony fringes of this minute Coccid rendering it a conspicuous object among the bustling ants. Although *D. poæ* is commonly found on the roots of several species of *Poa*, it attacks the roots of other plants, and occurs plentifully on roots under stones in nests of this ant. I have seen the adult females walking leisurely about the courts of the nest, where there were no roots near, each covered with masses of a white cottony substance. Twice have I noticed the little black ants ...ing ineffectually to carry off some of these large Coccids.

After several failures to do so the ant turned, walked backwards, and dragged the Coccids into the galleries. We have found nests situated under large boulders lying on fine sand, with no roots penetrating them, which contained several dozen adult females of *R. formicicola*. It is a common occurrence to find numbers of this Coccid, in all stages of development, attached to roots in the nests. I, however, can only conjecture that these adult Coccids were brought into these nests by the ants from elsewhere. They walk freely about the tracks and courts, but on what they subsist, in the absence of roots, I am at present unable to say. When viewed with a strong lens the walks and courts of the nests of this species exhibit the perfection of workmanship. In some of the nests we have observed groups of minute yellow eggs, together with clusters of those of the normal colour—white or reddish-white. On the 10th October, 1892, we found several nests, all close together, containing clusters of queen eggs, or those which develope into queens, while only a few worker-eggs were observed in the nests. In all ants' nests it is a simple matter to distinguish these eggs, chiefly from their size, and different periods of time required for their development. My knowledge of the latter is too imperfect at present to enter into details of their development. I, however, hope to be able to deal with this question in a future paper.

*M. integrum*, Forel, recently described, is the rarest species of the genus—at least, in the neighbourhood of Ashburton. Except in size, it closely resembles *M. suteri*, and is of similar habits. I have observed the two Coccids, *R. formicicola* and *D. poæ*, in two nests which we examined, under stones on the river-bed, a few miles above Ashburton. In structure it is a more slender and graceful form than any of the preceding species. At present I am unable to give full details of its habits.

*M. smithii*, Forel, is the smallest species of the native *Monomoria*. It exists generally in small communities on the river-bed here, and is readily distinguishable from all the native ants by its minute size and clear brown colour. The nests generally occur on sandy situations, among stunted vegetation, which support the Coccids associating with the ants. *R. formicicola* associates with them, and is tenderly carried off by the workers when the stone is raised off the nests. In young colonies which contain few eggs it is a common mode of concealment to rapidly burrow into and disappear in the fine sand on the bottom of the nest. The smallest nest of this ant we have noticed contained one queen, one male, and five neuters. As the colonies increase in numbers during the summer, dozens of adult females of the minute star-like Coccid, *R. formicicola*, are occasionally found leisurely walk-

ing about in the nests. The Acarians and Thysanura, already mentioned, are generally found in the nests of this species. On the 28th November, 1893, we discovered a somewhat large colony under a stone lying near some plants of *Carmichælia nana*. The roots of the latter were growing under the stone, and were badly infested with the *Ripersiæ*. The fine sand had been removed from under the roots, and left them clear in the nest. Attached to the roots were numbers of *Ripersiæ*, some of which the workers seized and removed to dark recesses in the nest. The ants had to climb up about 2in. of the perpendicular side of the nest to reach the horizontal roots. They each seized a Coccid, returned back along the root, walked down the wall, and disappeared into the recesses of the nest. It is therefore clear that the habit of preserving Coccids in their nests is general among the native *Monomoria*. Mr. Maskell states that the secretions yielded by these minute Coccids cannot be much. The species preserved by the ants are perhaps the only subterranean forms which secrete sweet, or at least edible, substances, so much sought after by the ants. Even the small amount secreted by some species is apparently sufficient to warrant our minute ants in protecting and preserving them in their nests. *R. formicicola* is a beautiful object when examined alive on a shaded field of the microscope.

*Prolasous advena*, Smith (= *Formica advena*, Smith; *Prenolopis advena*, Mayr): This peculiar ant is not uncommon on the Canterbury Plains. It is generally found in very large colonies, especially in limestone districts and in warm, rocky valleys sheltered from cold winds. The same habit of haunting the habitats of Coccids holds good with this as with the preceding species. As this ant is somewhat rare about Ashburton, I have not been able to study its habits and economy so fully as other species. It is a very timid and excitable ant, and no sooner is the stone raised off their nests than they present a scene of bustle and excitement. I have only twice seen them carrying Coccids about in their nests: but any further remarks on this ant I withhold for the present.

*Swarming of Ants.*—The calm, sultry days of February and March bring forth vast swarms of young ants to seek "fresh woods and pastures new" wherein to establish young colonies. For weeks before they take flight the nests are crowded with winged ants awaiting the proper time and natural conditions to do so. Seven years ago I recorded in the *Field* our meeting with a vast swarm of *M. nitidum* when driving across the Plains from Ashburton to Mount Somers. When we met the swarm we were moving at a walking-pace, and halted to witness it passing over us. In a few seconds horse, trap, and occupants were covered with minute winged ants. I alighted

and went towards the wire fence, which was also covered with millions of ants from the swarm. Many had cast their wings, while others again took flight and mingled with the dense swarm. The densest part of the swarm appeared to be about 6ft. to 10ft. from the ground, and flew at the rate of perhaps a mile an hour. As they proceeded numbers kept dropping out of the flight, and alighted on the tussocks, shook off their wings, and disappeared in the grass. As a natural means of distribution, the dispersion of immense swarms like the one under notice would thickly people with ants the line of country it passed over. An immense swarm of this nature could only be formed by the union of numerous nests which would be advantageous to the species. After the flight the queens meet and associate with males from other nests, and establish new colonies.

When referring in my former paper* to the general economy of the *Tetramoria* I stated that, "In order to ascertain if the *Tetramoria* form granaries or otherwise store food in summer and autumn for winter use, we have carefully examined many old nests in the months of April and May, but in no instance did we discover any food stored; we, however, have noticed a greater number of Aphides and Coccids in their nests during winter than in summer or autumn, and I think it probable that they are brought into the nests by the ants before the winter from beneath the adjacent stones." I have often observed ants with Coccids, excepting *Ripersiæ*, under stones apart from their nests. Owing to the presence of numerous rhizophagous Coccids—and in some cases Aphides—I am inclined to believe that these minute ants never possessed the instinct or knowledge of storing food. The milder climate and shorter winters at the Antipodes favour the ants in procuring food. When the relations of ants and Coccids are perfectly known, it will be found, I believe, that their mutual dependence will be, in many instances, more general, especially in temperate climates. The following case, from the report of the Inspector of the Cape (South African) vineyards for 1886, is of interest: "I have met with," the Inspector wrote, "a very singular subterranean Coccid, both at Moddergat and at the Praal, attended upon in one case by a small ant, *Acantholopis capensis*." The mutual relations of ants and Coccids, of ants and Aphides and the larvæ of several species of butterflies and other insects, require further investigation. In the case of some subterranean Coccids, they must belong to very ancient forms, especially so as species of the same genus are found in ants' nests in both hemispheres.

* *Loc. cit.*, p. 64.

I have now to thank Mr. Maskell, Captain Broun, and Professors Forel and Emery for naming and describing the new species of Coccids, Coleoptera, and ants submitted to them respectively. To Mr. H. Suter, who took much interest and trouble in forwarding the ants to Europe, my thanks are also due.

## ART. XLV.—*On the Construction of the Comb of the Hive-bee.*

By COLEMAN PHILLIPS.

[*Read before the Wellington Philosophical Society, 4th September, 1895.*]

DURING the past autumn, whilst shifting my bee-boxes, I disturbed a couple of hives to such an extent that the bees deserted them. These boxes were really double hives (two boxes to each hive), with a hole, 3½in. square, leading from the lower to the upper box. I had consequently a good opportunity of carefully examining the deserted comb in the lower boxes, which I will name A and B. To my surprise I noticed that the square hole in the top of box A had been bridged across by two walls of comb, whilst in box B a comb-bridge leading straight across the hole had only just been begun. This was all the comb in box B.

Box A, it will be noticed, is almost full of comb, lines of it stretching from side to side, and two of these across the square hole, proving that, in both instances, the bees, having apparently satisfied themselves of the dimensions of the holes, ignored them completely, and relied upon the bridging-powers of their comb-construction to span the distances. The fact that in box B the new line of comb (which, when complete, would stretch from side to side of the box) had been begun directly at the aperture, and the bridge of comb at once thrown straight across, almost reaching to the other side, shows how thoroughly the bees recognised the obstacle, seeing that they had the whole of the box at their disposal in which to start operations.

Darwin makes no reference to these honeycomb bridges in his "Origin of Species." All that great writer does is to strive his utmost to show that the comb of the hive-bee arose in accordance with his great theory of natural selection. He enters very fully into the cell-making instinct of the hive-bee. He cites other authorities to support his theory, which, if wrong in this instance, is certainly wrong throughout his

whole work. So completely do I disagree with the theory as explaining the origin of species, so certain am I that there is another force, energy, or intelligence in nature far superior to it (which I have named "a common vital force")—an intelligence that acts equally upon all living things throughout the whole universe we see around us—that I have determined to pin Darwin down to his own words in regard to this one matter of the cell-making instinct of bees, and to show, to the best of my ability, how the theory of natural selection fails to explain anything at all regarding bee-life—why it should, in some respects, resemble the busy life of a human community, or this wonderful specimen of what is called "instinct" in the construction of honeycomb. Oftentimes have my friends said to me, "Look how well Darwin explains his principle of evolution by natural selection in the superiority of the hive-bee cell to that of the humble-bee!" I propose now to ask members whether he tells us anything at all in this one special matter.

The following is Darwin's conclusion to his section (cap. viii., p. 227, "Origin of Species"): "Thus, I believe, the most wonderful of all known instincts, that of the hive-bee, can be explained by natural selection having taken advantage of numerous, successive, slight modifications of simpler instincts; natural selection having by slow degrees more and more perfectly led the bees to sweep equal spheres at a given distance from each other in a double layer, and to build up and excavate the wax along the planes of intersection; *the bees, of course, no more knowing that they swept their spheres at one particular distance from each other than they know what are the several angles of the hexagonal prisms and of the basal rhombic plates;* the motive-power of the process of natural selection having been the construction of cells of due strength and of the proper size and shape for the larvæ, this being effected with the greatest possible economy of labour and wax; that individual swarm which thus made the best cells with least labour, and least waste of honey in the secretion of wax, having succeeded best, and having transmitted their newly-acquired economical instincts to new swarms, which in their turn will have had the best chance of succeeding in the struggle for existence."

Nothing can be plainer or more emphatic than these words as explaining the theory of natural selection. I have italicised certain words in order not only to show how mistaken this conclusion was, but also to emphasize the existence of this constant guiding vital intelligence, of which Darwin took no account. There is no reference to the words, "vital intelligence or force" in Darwin's index. It is of no moment whether he himself compiled the index or the index was compiled for him:

I should certainly think he supervised it. But it is quite plain that so little was thought of these two words that they were omitted from the index. In his conclusion Darwin certainly continues with the words, "the motive-power of the process of natural selection," as being sufficient to account for the cell-construction of the hive-bee; but no person has yet granted natural selection to be a motive-power. Every one admits that vital intelligence is a motive-power, because we all experience it, although we do not know what it really is; and we can all further admit that natural selection is one method by which that intelligence acts, subject, however, to the higher law of progressive adaptation of species. That is to say, that each species, like a magic puzzle, has *in itself* the power to change, to adapt itself, to build cell on cell, by a thousand thousand different modifications, so as to enable it to suit itself to new environments. I pointed this out in section iii. of my paper—"Potentiality of Divergence."*

The bridging principle of construction in the comb of the hive-bee can be seen at a glance in both boxes on the table. There is no simple cell-construction in the bold manner in which the bees throw their comb straight across the two holes —no simple "sweeping of equal spheres from respective distances." Again, it will be observed that the walls of comb stand at certain distances from each other—never less than three lines, but usually six lines—that being, I suppose, as far as the bees can reach between wall and wall of comb. Surely the bees *know* what they are doing when rigidly keeping the different lines of comb at these stated distances. For it will be observed that, no matter how the bases of the hanging walls of comb start, whether in straight or diagonal lines, each single wall rarely approaches a neighbouring wall within three lines. These bases, indeed, can start anywhere in the box, because the bees evidently possess two separate pieces of knowledge amongst many others: (1) The average length of the rhombus or cell to accommodate the larvæ; (2) the distance to be observed between the walls of growing comb. Possessing these two pieces of knowledge, which Darwin does not credit the bees with, as well as the "instinct of the sweeping of spheres" to form the cells, which he does credit them with, the bees can fill in a space anywhere in the box. The result always is that a box becomes filled with walls of live comb at stated distances apart, and the two layers of cells of fairly equal lengths. But should a growing wall of comb come in contact with a neighbouring wall, as sometimes happens, that contact is immediately stopped, and the point of contact forms a stay. It will be observed that these stays

* Trans. N.Z. Inst., 1898, p. 611.

are numerous round the sides of the box. This is evidently to strengthen the walls of comb and keep them firm, the stays rarely impeding the free passing of the bees round the hive.

In Article lxxi. of our Transactions of 1893, "Spiders as Engineers," I pointed out how beautifully spiders stayed their webs, and showed, moreover, that some of our own suspension-bridges (notably the one in Hobson Street, Wellington) are stayed exactly in a similar manner. Now, if any person closely examines box A he will observe somewhat similar stays all round the box, but rarely between the walls of comb. What, then, is the intelligence that guides insects and animals to stay their constructions in this way? Wherein does the theory of natural selection account for it? Does nature, under that theory, thin out all the variations of the different species until only those survive which know how to adopt this principle of staying? For that is the constant argument: "Only those survive that have been naturally selected to survive." Now, granting this argument, under the higher law of progressive adaptation, how does the theory account for such widely-different species as man, spiders, and bees using almost the same principle in staying their widely-different structures? For, whether the stay is made of wax, web, or iron, there the principle is all the same. To say that "Similarity of object leads to similarity of means" implies that there is in nature a previously-existing method or means to a particular end for all species.

Furthermore, it will be observed that the walls of comb run fairly straight: so that bees know how to make fairly straight lines, as well as how to make bridges. I do not say that every wall is absolutely straight—there are curves in some—but the tendency is to run straight lines. Of the three centre lines of comb in box A, the bees, it will be observed, had a guide for two of the walls in the little gap where the two boards forming the top of the box should have closely met. The third wall, of course, followed the centre wall near the gap after it had been constructed.

The reason for the diagonal walls is not clear. I have seen boxes of comb with all the walls fairly parallel and straight excepting in one corner, where the beautiful white comb forming the queen's home is built. This comb is usually built diagonally, perhaps for purposes of easier defence should an enemy invade the hive. The fact of aiming at straight lines at all, even in the diagonal walls, shows a bee's further knowledge, which Darwin ignored. I do not for one moment mean to say that the principle of natural or artificial selection is absolutely non-existent in nature. What I mean is that in the higher law of progressive adaptation of species, natural selection plays, as I have said, only a minor part.

I may be allowed here to digress for one moment to give an example of progressive development which forms one phase of progressive adaptation as distinct from the theory of natural selection. It was formerly supposed that a very minute crustaceous animal inhabiting the open sea, named Zoea, was totally distinct from the genus Megalopa, which again was supposed to be totally distinct from every known genus of Crustacea. Gosse very clearly points out that "These conclusions were set aside by the brilliant discovery of Dr. Vaughan Thompson that Zoea and Megalopa were the same animal in different stages of existence; and that, moreover, both were but the early states of well-known and familiar forms of larger Crustacea, which therefore undergo a metamorphosis as complete as that by which the caterpillar changes to a chrysalis and the chrysalis to a butterfly, and in every essential point parallel to it. In the Cove of Cork Dr. Thompson met with a considerable number of Zoeas, which he kept in captivity. Some of these changed into the Megalopa form, which in turn changed to the most abundant of all our larger Crustacea, the common shore-crab (*Carcinus mænas*). Thus, in its progress from the egg to its final development, the crab was forced to pass through two temporary conditions, which had previously been regarded as types not of genera only, but of different families, and both strikingly dissimilar from the group to which, in its perfect state, it belongs."

Here we have an example of progressive development which quite puzzled Darwin himself under his own theory. But we know of many other instances of peculiar stages of development in nature to which the theory of natural selection does not at all apply, and I propose to refer to them later on.

But let us proceed. It will be observed that the sides of the comb-walls—the ends of the layers—are finished off almost in perfect planes. Pass the fingers carefully over them, and, no matter whether the distances between the walls be three, five, seven, or nine lines (for my non-scientific hearers I may explain that twelve lines go to the inch), it will be seen how beautifully the bees know when to cease the length of the cell or rhomb. (In geometry a rhomb or rhombus is an oblique-angled equilateral parallelogram.) Here is a further piece of knowledge on the bees' part of which Darwin took no account. I may explain that it is by the dexterous use of their stings that the bees finish off and cap their cells, injecting a minute portion of formic acid into the honey as the cell is filled and closed. This acid is really the poison of their stings, and it imparts to the honey its peculiar flavour and keeping-qualities. The sting is an exquisitely-contrived little trowel, and it greatly helps in giving the plane surface to the sides of the layers. I may further be allowed to say that to describe the cylindrical

tongue of the bee, which laps up the honey, almost exceeds, according to Suammerdam and Gosse, the utmost efforts of human knowledge.

Now, hold a piece of comb up to the light, or break off a piece. It will be observed that the cells forming each side of the comb-wall—the two layers—do not start from the same base. The hexagon is not continued straight through the wall, but is broken in the centre, forming the basal rhombic plate. This I take to be the most marvellous work of construction in the comb; for here the bees know exactly how to break the joint, for the special purpose, I suppose, of giving strength to the comb-wall and to the two opposite cells.

There is no "blind sweeping of equal spheres at stated distances" in this breaking of the joint, for the bees know exactly how to place and plane the basal plates and angles out of the wax so as to perform this most delicate and wonderful principle of construction. Therefore, whatever the guiding principle of construction in nature may be which controls such a work, the principle of natural selection is not within a thousand miles of it. We can admit, for the sake of argument, that there may be a principle of natural selection—I do not for one moment say there is—between the simple cocoons of the humble-bee and the cells of the hive-bee, of which the cell of the Mexican *Melipona domestica* is the intermediate stage. This is what we are asked to admit. Pierre Huber, however, who has carefully described and figured the cell of *Melipona domestica*, calls it a "gross imitation" of the three-sided pyramidal base of the cell of the hive-bee. Darwin ignored these words completely, and made use of Huber's name as a support for his theory. But what has this very short series of natural-selection stages—(so very short a one, with so few examples, and these so very uncertain, that I am completely surprised Darwin did not himself candidly admit his want of proof, in place of taking it for granted that we should accept his theory as a matter of course: he, moreover, drawing in the name of Professor Nyman to support his assumption by the statement that "the accuracy of the workmanship of the bee has been greatly exaggerated")—what even has this short series to do with breaking the joint at the base of each cell? Surely the bases might have been equal in the layers for the starting of the sides of each rhombus! But they are not so, and the bees know that they are not to be so, just as surely as the horse-bot knows that the safest place to deposit its eggs is just beneath the horse's chin. Evolutionists will, of course, say that the horse-bot has been naturally selected to do this. I propose to expose the fallacy of such an argument later on.

It is not necessary for me to go into the actual details of the cell-making, the gathering of the honey and the secretion

of the wax, its deposit, working and planing off into hexagonal or basal plates. An observer must watch the bees at work in a glass hive, or read any bee-book upon the subject. The sets of combs on the bees' hind feet for scraping up the pollen, and the little baskets or paniers on the tibia joints immediately above these combs for carrying it to the hive, are so wonderful in their construction that I can only marvel at this one display of Divine intelligence. My mind positively recoils from ascribing it to any blind principle of natural selection. I will admit a slight "sweeping of equal spheres at given distances," because the bees have to work in the dark by feel and sound, and to economize space. There are, I think, one or two other senses than ours amongst bees, of which we at present know little or nothing. In referring to this point Gosse says, "The comparative moisture or dryness of the atmosphere, delicate changes in its temperature, in its density; the presence of gaseous exhalations; the proximity of solid bodies indicated by subtle vibrations of the air; the height above the earth at which flight is performed, measured basometrically; the various electrical conditions of the atmosphere; and perhaps many other physical diversities which cannot be classed under sight, sound, smell, taste, or touch, and which may be altogether unappreciable, and therefore altogether inconceivable, by us." To which I may add now the "sembling" of insects, more especially that of the oak egger-moth (*Lasiocampa quercûs*). But there are a hundred marvels of vital action, energy, or intelligence connected with a bee-hive—such as the bees always turning their faces to the queen (just as man does to his queen) as she moves through the hive; their choice of a queen, and all the struggles consequent thereupon; their building a palace of beautiful comb for the queen, and its strategical defence; their killing off the drones or superfluous bees before the winter sets in; their crooning the night before swarming, just as men and women croon and cry when they have to leave their parent homes; their swarming, and their hanging about in the vicinity of the parent hive for two or three days in order to see whether man will put them in a box and place them near their birthplace; their harmlessness whilst waiting about, and the ease by which an experienced bee-taker can sweep them with his bare hand into their new hive, &c. All these things rest upon the immutable principles of a guiding vital intelligence, from which natural selection is as far removed as the sun from the earth. All this is done by what we have perhaps mistakenly named "instinct."

But closely examine the new swarm when clustering upon a bough—there is little danger, as bees rarely sting during swarming time—it will be observed that the individual bees are constantly on the move; those on the inside coming to

the outside of the cluster, and those upon the outside going inwards to relieve those holding on to the bough, and to give them a spell from bearing the heavy weight of the cluster. The young bees, new to life, know that it is their bounden duty to do this, and not to go flying about seeking honey. Will any person for one moment say that the bees have been taught to do this sensible work by the principle of natural selection?—that only those bees have survived which have known how to swarm properly? Or will they not admit with me that there is some guiding energy or intelligence which tells the young bees how to swarm now, as it has told them for a million years, and just as it tells them how to plane and shape the basal rhombic plates of their cells?

It will be noticed in box A that the hanging wall of comb grows downwards until it reaches the bench upon which the box rests within a distance of about ¼in. Pass a straight-edge over the box and this space will at once be seen. This space is left for ventilation and room in the hive. The bees have to think of proper ventilation just as we have. On very warm, calm days a certain number stand at the entrance to their hives and convert themselves into miniature air-fans by rapid vibration of their wings. No doubt the comb-walls are constructed to afford a free ventilating-space. The cell therefore lengthens outwards as the comb-wall descends, the wall itself usually having a sharp edge, which is the first forming of the basal rhombic plates. But, no matter how these wonderful basal plates start, the rhomb or cell very slightly curves outwards from them, and lengthens to its proper position in the layer. There appears to be only one set of basal plates in the comb-wall, even when one side of the wall is lengthened to three times the ordinary length of the cell so as to form a stay. Of course, there cannot well be more, otherwise there would be a closed and vacant cell in the centre of the wall. The bees know quite well how and when to make their cells of different lengths as circumstances require. In this a most marvellous intelligence is displayed, the cells having to vary by gradation from the ordinary to three times their ordinary length. The mere fact of lengthening the cell into different lengths as required shows that there is a guiding principle at work far removed from the mere "blind sweeping of equal spheres at stated distances." The bees work from cell to cell, from base and angle, with mathematical precision, leaving the whole wall a perfectly-finished work. The marvel lies in this continuity of simplicity in the angular construction, proving undoubtedly to any unprejudiced mind that there is no blindness whatever in the bees' mode of working.

But can it be said that the hexagonal cell is the result

of a sweeping of an equal sphere at all? Examine the cell. It is six-sided, almost mathematically correct. The basal plates of the rhomb do not form a plane, but contain three faces or oblique angles too, so that I cannot see where the "sweeping of equal spheres" finds place in this construction. They may start the cell by sweeping a sphere, but there is no sphere left by the time the cell is finished. The bees measure the cell-distances in the layer by the size of their own bodies; and then the principle of construction is hexagonal and not circular. The cell of the humble-bee is circular; that of *Melipona domestica* circular, and oftentimes a "gross imitation of the cell of the hive-bee." But can any person say that the cell of the hive-bee is not the proper cell, devised and perfected by nature, and that the humble-bee cell and that of *Melipona* are only variations? As a rule, it is the humble-bee that drives the hive bee away. What ground, then, has Darwin for applying his theory to this construction at all? Do his instances prove his argument? Can they not be read entirely the other way—namely, that they are but degraded variations of the proper cell? And if we find that Darwin has been absolutely mistaken in applying his theory to this one insect, what value are we to attach to his other instances of proof? The cell of the humble-bee ought to be far and away superior to the cell of the hive-bee, but it is not so.

Darwin, moreover, names it as "the most wonderful of all known instincts, that of the hive-bee." In my opinion he is wrong. The ant shows a far more wonderful display of what is called "instinct." I shall refer later on to the ant. The bee, ant, spider, and man show similar knowledge of exactly similar subjects. To say that the bee works without this knowledge, but simply owing to "blind evolution by natural selection, having taken advantage of numerous successive slight modifications of simpler instincts" (which modifications and instances are not given), is to me a proposition quite untenable.

A hive swarms. A certain number of the older bees may, or may not, accompany the queen and the young bees. These may or may not teach the new swarm how to begin their labours and use their little planes—like our carpenter's planes —to level off and reduce to a uniform thickness the walls of their cells. And let it be noted how beautiful and perfect the wall of the hexagon is—never breaking into an adjoining cell, but a perfectly watertight compartment for holding its store of honey, food, or young larvæ. In my opinion there is no necessity for the young brood to be taught how to go to work any more than it is taught how to swarm. In the realm of nature throughout the whole universe we see around us, certain common vital laws rule. A young hive-bee goes to work with its

little tools and builds its cell in the most cheery confidence, because it knows that food in flowers has been provided for it, and because it has been designed to build the cell exactly in this special manner to store its food. It has been as much designed to do this as it has been designed to fertilise plants. Will any person who objects to the word "designed" kindly explain how it is that numerous species of plants depend for existence and propagation almost entirely upon the visits of bees? We know of no other principle of construction that will hold so much liquid so well and in so small a space as that of the cell of the hive-bee. There is the cell of the mason-wasp, which is a very wonderful structure too, although oftentimes a great nuisance to us in New Zealand. But this cell is round or oblong, with no oblique angles—a much more simple construction than that of the hive-bee. Moreover, it is built of clay, not of wax. How is the doctrine of natural selection to explain this one vast difference of material in exactly a similar operation? True, its whole purpose is different, but nevertheless a cell is built.*

But after the swarm has been taken, away the young bee flies. It may have to fly a mile or more; but it brings back its nectar, unerringly selects its new home out of a row of perhaps twenty boxes, and sets to work just as I suppose its ancestors have worked throughout all time.

The dividing wall of the two layers of cells are named "basal rhombic plates." I cannot define more than three plates with clearly-formed and beautiful oblique angles. Yet in his conclusion Darwin says, "the bees, of course, no more knowing that they swept their spheres at one particular distance from each other than they knew what are the several angles of the hexagonal prisms and of the basal rhombic plates." Now, I ask any one really desirous of testing these statements—(and, notwithstanding the weight of authority Darwin makes a point of always bringing to support his arguments, I hold that every one of his statements requires the most careful testing and verifying)—to look at these basal plates of the cell and ask himself whether the bee *knew* what it was doing or whether it did not? If not, if it only acts from the blind principle of evolution and natural selection that is immediately afterwards referred to in the conclusion, why is it that each basal plate is

* The mason-fly, by some method I cannot explain, stupefies, either by injecting a fluid or paralysing certain nerves, the spider which it has entombed in the cell with its egg. This stupefaction lasts a period of two to four months. The larvæ of the fly hatch out and feed upon the beautifully-preserved body of the spider. I have often thought that this process of stupefaction should be carefully investigated, in order to see whether nature has not in this matter shown us an example whereby we might preserve our meat.

exactly alike, and as mathematically correct as a spider's web? What is it that keeps these angles uniform right through the comb-wall?—for a well-constructed oblique angle is not a mere blind sweeping of a sphere.

To give Darwin every credit, which I naturally wish to give to so great a writer, I will say this: that, if this instance of natural selection in regard to the hive-bee cell he has given us offers any proof of his theory to scientific minds (I regret it does not to mine), then at best it is but an exemplification of the law of progressive adaptation of species. The hive-bee, the humble-bee, and *Melipona domestica* are each useful for its particular work. Red-clover, for instance, in New Zealand could not be fertilised until we introduced the humble-bee. It is also said in Canterbury that the humble-bee in some places takes all the honey from the flowers, leaving little or none for the hive-bee. The cell of the humble-bee should therefore be far superior to the cell of the hive-bee. But Darwin places the cell of the humble-bee at the bottom of the scale, and most unmistakably says that *Melipona domestica* and the hive-bee cells have been naturally selected from it. To say that the humble-bee is evolved by natural selection from the hive-bee, or *vice versâ*, or that the hive-bee cell is naturally selected from the Mexican-bee cell, looks to me quite absurd, even from Darwin's own proof. As Pierre Huber distinctly says, "The Mexican-bee cell looks like a gross imitation of a portion of the hive-bee cell." Moreover, we have in New Zealand many native bees which build simple single cells in the ground for storing their food. The humble-bee cell is almost a clay cell. Wasps in Europe build their nests of clay. But all these are quite different structures to the finished cell of wax of the hive-bee. Again, even in the hive-bee cells there is no blind sweeping of equal spheres, seeing that the cells for the queen-bees are considerably larger than those for the common bees of the hive, and are also differently constructed.*

* I attach the following description of the cell-formation and work of the queen-bee as bearing upon the question. I regret my inability to give the author's name: "The province and occupation of the queen-bee consist in laying the eggs from which originate the prodigious multitudes that people a hive. Every bee in the community is apparently aware of this fact, and consequently treats her with due respect, even to the extent of never turning its back upon her until, the hive being overcrowded and a new queen having been made, a swarm is thought necessary, when all respect disappears, and, should she show the least reluctance, she is forced out to seek new quarters with other emigrants. The creation of a queen is one of the greatest wonders of that most wonderful of insect communities—a hive of bees; for no sooner does the old queen die, or the members of the community become convinced that they are overcrowded, and that a swarm is necessary, than they begin to build one or more queen-cells, which are utterly unlike the well-known hexagonal cells in which honey is stored or the brood of either workers or drones is reared,

There are many other points to be considered in this matter of honeycomb-construction and the cell-making instinct of the hive-bee, but I will rest content with the points I have already raised, merely asking any unprejudiced person whether Darwin's premises and conclusion are borne out in this one instance by his theory of natural selection. In Brazil there is a bee that builds its comb on the very outmost twigs of lofty trees, as a protection against climbing and marauding enemies. Wherein does this exhibition of intelligence differ much from the New Guinea natives building their huts in lofty trees for similar protective purposes? To my mind, very little. Yet we are asked to admit that bees live their life and work in sole accordance with a blind principle of natural selection.

being in shape and size not unlike an acorn. In each of these, if more than one, either a worker-egg—worker- and drone-eggs being dissimilar, and laid in different comb—or a worker and worker-larva not more than three days old is placed, and the larva is fed with peculiar food, called "royal pap" or "royal jelly," with the result that in sixteen days—five days less than would be required for a worker and nine less than for a drone—a queen, or perfect female, is produced. She alone has a life extending to years, that of the workers being limited to months at the longest."

## III.—BOTANY.

### Art. XLVI.—*Notes on MS. Descriptions of Collections made during Captain Cook's First Voyage.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 25th September, 1895.*]

It affords me great pleasure to comply with the request of Sir James Hector to give a short account of the valuable type-written MS. which he has had laid upon the table this evening. It will be remembered by all present that the most famous of modern navigators, Captain Cook, was accompanied on his first voyage by two naturalists who took their place amongst the foremost scientific men of the day—Sir Joseph Banks and Dr. Solander—the entire cost of the natural-history investigations made during the voyage being defrayed by the generosity of the former. Captain Cook first landed on the shore of New Zealand at Poverty Bay, on Sunday, the 8th October, 1769, and subsequently visited Tolaga Bay, Opuaragi (Mercury Bay), the Thames River, the Bay of Islands, Queen Charlotte Sound, Admiralty Bay, &c., during which the naturalists collected about 360 species of flowering-plants and ferns. But they were no mere collectors: folio drawings of most of the plants were made by Sydney Parkinson, one of the draughtsmen engaged for the voyage, and on the return of the expedition to England were engraved on copper; while excellent MS. descriptions were prepared by Dr. Solander, the entire cost being defrayed by Banks. Unhappily, these plates and descriptions have never been published. At the instance of Sir James Hector, the Board of Governors of the New Zealand Institute authorised the necessary outlay for copying the descriptions in London, and the MS. is now submitted for inspection. Sir Joseph Hooker, in the introduction to the original "Flora Novæ-Zelandiæ," speaks of Solander's MS. in very high terms, and from such references as I have already been able to make I can heartily indorse his testimony to its merit. It is most unfortunate that for a century and a quarter plates and descriptions alike have remained inaccessible to local botanists. Had they been published by their

authors, the botany of New Zealand would have been far better known sixty years ago than was possible under the conditions that then existed, a large amount of error and confusion would have been avoided, and the synonymy of many species greatly simplified. Many of Solander's names, which in the majority of species are most appropriate, have been applied to different plants, while others have not come into use in any way, many New Zealand plants having been described by Continental writers who had no knowledge of Solander's excellent work.

It is perhaps not generally known that Sir Joseph Banks was extremely anxious to accompany Cook on his second voyage, and succeeded in having a grant of £4,000 voted by the House of Commons to pay for the necessary assistance; but, owing to the resolution not being sufficiently well defined, the Comptroller of the Navy, who from some obscure cause wished to thwart Banks, succeeded in preventing him from joining the expedition. John Reynhold Forster and his son George were appointed chief naturalists, and received the sum voted by the Government at the instigation of Sir Joseph Banks. Their botanical work, although of great value, was not equal to that of Banks and Solander either in extent or quality. Their collection of New Zealand phænogams and ferns comprised only 160 species, of which about 150 were published in George Forster's "Florulæ Insularum Australium Prodromus." A few others were described in "Characteres Generum" and "De Plantis Esculentis Insularum Oceani Australis Commentatio Botanica," but the descriptions are very meagre, and suffer greatly by contrast with the excellent work of Dr. Solander. The specimens collected by the Forsters were arranged in fasciculi and distributed to various museums and private collections. Unfortunately, in some instances a plant has received different names in different fasciculi, resulting in a large amount of error and confusion. Their drawings of the plants and animals collected during the voyage were purchased by Sir Joseph Banks for £400, and are included in the Banksian Collections now in the British Museum. It is worth while to remark that the three works already mentioned, with another, "De Plantis Magellanicis et Atlanticis," all published between 1776 and 1787, comprise all that was published respecting the botany of Cook's first and second voyages, and therefore all that was published respecting the botany of New Zealand prior to M. A. Richard's "Essai d'une Flore de la Nouvelle Zélande," in 1832. In this connection I should like to state my sense of personal indebtedness to C. R. Carter, Esq., who, at my suggestion, has kindly placed copies of these books in the fine collection of works on New Zealand which he has so generously presented to the

New Zealand Institute. Apart from their special value to the botanist, a considerable amount of historic interest must be attached to them by all New-Zealanders.

At the risk of seeming somewhat egotistical, I should like to state that the Minister of Education has sanctioned the small outlay necessary for obtaining a complete set of proofs from the Banksian drawings of New Zealand plants in the British Museum, and that copies reduced by photo-lithography will be printed at the Government press, to form a special volume of illustrations for the "Student's Flora of New Zealand," now in preparation. The MS. volume of descriptions now on the table will be bound for the library of the New Zealand Institute.

I am reluctant to allow this opportunity to pass without expressing my thanks to Sir James Hector for his continuous and loyal efforts to insure the new Flora being made as complete and exact as possible. When its publication was first mooted some years back he advised the Government that, as a simple matter of business, it would be wise to send the editor to London to examine the collections of New Zealand plants made by the early botanists, and especially the vast accumulations that have been sent to Kew during the last thirty or forty years. The same course had previously been suggested by Sir Joseph Hooker, but had not been brought under the notice of the Government. When the Government declined to adopt the advice Sir James warmly supported the proposal to secure the MS. copy of Banks' and Solander's unpublished Flora, which is now before the meeting, and thus rendered material assistance. He has done everything in his power to facilitate the work and render it as nearly perfect as possible. I gladly take this opportunity of acknowledging his many good offices.

## Art. XLVII.—*Notes on* Dactylanthus taylori, *Hook. f.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 25th September, 1895.*]

The remarkable monotypic genus *Dactylanthus* constitutes the fourth tribe of *Balanophoreæ*, an order of root-parasites most of which have a very local distribution. *Dactylanthus*, the "pua-reinga" of the Maoris, was originally discovered about 1857 by the Rev. Richard Taylor, growing on the roots

of *Pittosporum*, *Fagus*, and other trees near the head of the Whanganui River, at an estimated altitude of 4,000ft. Although the plant grows over a wide area it is remarkably local, so that it is desirable to record the localities in which it has been observed. After its original discovery it does not appear to have been noticed by any collector until April, 1869, when I had the good fortune to discover it, at an altitude of 1,800ft. or 1,900ft., on the Thames Goldfield, where it was parasitic on the roots of *Schefflera digitata* and *Coprosma grandifolia*; but, owing to the advanced period of the summer, the specimens were so much decayed that only the rhizomes were in a fit state for removal: several of these were deposited in the Colonial Museum.* It was decidedly rare, and was limited to a very small area. Although I paid several visits to the habitat in subsequent years, the complete destruction of the arboreal vegetation by mining operations appeared to have killed the parasite; but I believe it has been recently collected by Mr. Cheeseman, either in the habitat where it was first observed by me or some other in its near vicinity. It was next observed by Mr. J. P. Marshall on the banks of the Mohanga River, Rangitikei, and he kindly presented me with a male specimen in 1878. In 1887 it was collected by Mr. W. H. Skinner in the Taranaki District, but I am ignorant of the exact locality, although Mr. Skinner generously forwarded his specimen for my herbarium. It is the only female specimen that I have seen; the fruits are fully formed, but not ripe. Two small specimens were very kindly given me at a later date by Mr. H. C. Field, who found them in the Whanganui district, but did not state the precise locality. More recently it has been discovered in two localities by Mr. A. Hamilton—at Tarawera, between Taupo and Napier, and at Nuhaka, near the Mahia Peninsula. I am indebted to his goodness for a specimen from the latter habitat. It has also been found in considerable quantity in the forest district between Clyde and Waikaremoana, but the discoverer's name is unknown to me. Lastly, it has recently been found by Mr. H. Hill in the East Cape district, where it evidently grows in great luxuriance, judging from the fine specimen which he has liberally presented to the Colonial Museum; it measures fully 8in. across, and is by far the largest that has come under my notice.

Unhappily, most of the specimens at present obtained are in very poor condition, and enable us to add but little to the excellent description drawn by Sir Joseph Hooker from the material collected by the Rev. R. Taylor. The following notes are written in the hope that they may prove of sufficient

* See Trans. N.Z. Inst., ii. (1869), p. 94.

interest to draw the attention of surveyors, explorers, and settlers in forest districts to one of the most remarkable plants in the flora.

The large rhizome by which it is attached to the roots of its host is usually subterranean, very woody, rounded or amorphous, entire or deeply lobed, and forms a kind of boss, covered on the surface with rounded papillæ, each of which marks the point at which a flowering-stem was given off. The rhizomes vary greatly in size; some might be completely hidden under a penny-piece, while others are fully 8in. in diameter and 4in. or 5in. thick. When growing on a declivity, roots of the host-plant, from which the soil has been washed away, may be found with the rhizome of the parasite fully exposed, when the position of the flowering-stems is easily made out; but usually the rhizome is buried in the humus amongst which it grows, and only the upper part of the flowering-stems rises above the soil to a greater or less extent.

The flowering-stems are diœcious, from 2in. to 5in. long, somewhat club-shaped, and clothed with brown ovate or oblong imbricating scales, which are evidently fleshy when first developed, but at length become so brittle that they crumble into minute fragments at the slightest touch. The flowers are developed on very short spadices, 1in. to 1½in. in length at the apex of the stem, and are mostly hidden by the apical scales; the males, which I have not seen, are covered with crowded anthers, and the females with sessile ovaries in great profusion. The ripe fruit is about the size of a radish-seed, and contains a minute undivided embryo, imbedded in granular endosperm. Unhappily, nothing is at present known of the process of germination and development.

Although the dull-brown colour of the flowering-stems renders the portion that appears above ground very inconspicuous, the flowers emit a strong perfume. In a letter to Sir James Hector, Mr. Hill states that he was enabled to discover the plant solely through the "delicious daphne-like fragrance which it emitted," his attention being first attracted by the perfume.

The large area over which it has already been observed, extending from the Hauraki Gulf to Taranaki and Rangitikei, warrants the idea that a careful search would be rewarded by its discovery in localities where its occurrence has not hitherto been suspected. Any explorer or settler who would communicate a supply of good specimens would render a great service to botanists at large, although there is nothing in the material that has come under my notice to support the idea of there being more than a single species.

*Further Notes, read 16th October, 1895.*

The following extract of a letter from Mr. A. Hamilton, informing me of the discovery of *Dactylanthus* at Tarawera, will be read with interest. It is dated 28th March, 1888:—

"Some time ago, when I went to Lake Waikaremoana, you were kind enough to send me a list of plants which I should endeavour to find, and made particular mention of *Dactylanthus taylori*. Although at that time I was not fortunate enough to see or hear of any specimens, I have been on the look-out for it ever since, and last week, when collecting at Tarawera, on the Taupo-Napier Road, I found it.

"I was searching under the trees at the top of the ranges for *Cordyceps robertsii*, and picked up a scaly bud like an immature cone. On looking about to see where it had come from I found a tuberous-looking mass, about 10in. by 6in., covered with the circular scars from which these small spike-buds had fallen. Disposed irregularly round the mass were two different kinds of brown scaly spikes, the male (?) being much longer than the female. Remembering that you asked me to examine the manner in which it was attached to the root of the tree, I removed as much as possible of the vegetable mould and decaying leaves which partially covered the plant, and, finding a small tuber, bearing two or three good spikes, apparently distinct from the main mass, I carefully cut away the root of the tree and placed it, with the plant and the surrounding soil, in a box, carefully packing it with moss so that it could not shift. I then cut two or three of the mature male and female spikes from the larger plant, which I left carefully covered with branches. I tried to trace the root on which it seemed to grow back to the trunk of the tree, and uncovered it all the way. Even then it was hard to say what tree it was, as three—a *Fagus*, a *Pittosporum*, and some other—had their roots closely intermixed. Some little distance away I found the remains of another small mass, which had been broken up by a falling tree. . . . I carefully examined the tuberous portion, and found that, although it rested on the root of the tree, there was no attachment of any kind, but a woody root passed down the lower part of the tuber into the ground: this, unfortunately, I had cut through. The representation given by Taylor is fairly good, but the tuber seems to be growing from the root of the tree instead of on its own, and must have been from a larger specimen than mine."

Mr. Hamilton has suggested a question of considerable importance, one perhaps that can only be determined by watching the development of the plant from the embryo. In the large specimen presented to the Colonial Museum by Mr. Hill the woody rhizome viewed from below presents every

appearance of true root-parasitism, so far as can be determined without the destruction of the specimen; the same is to be seen in a specimen from Nuhaka which I exhibit to-night. At the same time, there can be no question that, as the woody rhizome extends over the surface of a large root, it adapts itself to the contour of the root without developing new organs of attachment—at least, in certain instances, probably in all.

On the other hand, I exhibit a young specimen the rhizome of which forms a small disc, scarcely exceeding 1in. in diameter and ⅛in. in thickness; a tortuous woody root appears to have developed directly from the centre of the lower surface of the disc, and has attained a total length of 6in. or 7in. There is a very regular expansion of the supposed root upwards at the junction with the rhizome, and with our present knowledge it does not seem possible that this can have been produced by parasitism. For the present I hesitate to interfere with this root in any way until further specimens of a similar character can be obtained, when careful dissection of the point from which it is given off, and a microscopical examination of its structure, will doubtless throw light upon the subject. I have little doubt that specimens of this kind are more frequent than might be expected.

Mr. Hill assures me of his conviction that the plant is truly parasitic for the whole term of its existence, and that it never developes true roots. If we may suppose that it is at first parasitic and only produces true roots after attaining a certain stage of development, we have exactly the reverse of what takes place in such plants as *Cuscuta*, the radicle of which forms a true earth-root immediately after germination; but as soon as the stem produces haustella, which enable it to absorb the assimilated juice of some other plant, the root perishes. The process would be closely analogous to that exhibited by the native sandalwood (*Fusanus cunninghamii*), and the "eye-bright" (*Euphrasia cuneata*), &c., the roots of which become attached to those of other plants, and for a time at least absorb the chief portion of their nourishment in an elaborated condition. The facts, however, are still obscure, and much has to be done before the difficulties surrounding the subject can be properly cleared up. My only excuse for again drawing attention to *Dactylanthus*, while still unable to make any material addition to our knowledge of such an interesting organism, must be the hope I entertain that by this means the assistance of observers favourably situated for examining the plant in the living state may be more readily obtained.

# Art. XLVIII.—*On* Zannichellia *and* Lepilæna *in New Zealand.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

*Zannichellia palustris*, L., was first discovered in New Zealand by Colenso; it was included by Sir Joseph Hooker in his original "Flora of New Zealand," published in 1853, and subsequently in the "Handbook of the New Zealand Flora," Colenso's habitat on the East Cape being for many years the only local station recorded for the plant. On its discovery in the Waikato in 1870, the learned Baron von Mueller suggested the strong probability of its belonging to the Australian genus *Lepilæna*, the principal species of which were formerly confused with *Zannichellia*, and, at his request, some of the Waikato specimens were submitted for his examination, when they were kindly identified by him as *Lepilæna preissii*, F. Mueller. The plant exhibited a very close resemblance indeed to a European form of *Zannichellia*, with the achenes on long slender pedicels, the similarity extending even to the form of the ripe fruits. This identification, however, led local botanists to assume, somewhat hastily, that, as in Australia so in New Zealand, all plants hitherto indentified as *Zannichellia* must be referred to *Lepilæna*; and the older genus was completely neglected until three or four years ago, when Mr. Petrie detected *Zannichellia palustris* in Otago, and I had the pleasure of collecting it in flower and fruit in the Makararoa Stream, Hawke's Bay, a locality which affords strong support to the accuracy of Sir Joseph Hooker's determination of Colenso's original specimens. As it is probable that both *Zannichellia* and *Lepilæna* are of more frequent occurrence than has hitherto been supposed, it seems desirable that attention should be drawn to the chief characters by which the members of these closely-allied genera may be most readily identified. Both are inconspicuous submerged aquatics, with capillary stems and leaves, and axillary apetalous flowers; the leaves in both are from ½in. to upwards of 1in. in length.

*Zannichellia* is monœcious. The male flower is enclosed in a membranous bract, and consists of a single sagittate anther, with the filament at first short and stout, but ultimately much elongated. The female flower is also protected by a membranous bract, and consists of from four to six carpels sessile or shortly stalked, with short styles and capitate stigmas. The

fruits are curved achenes, tipped with slender styles, and arranged in fascicles of from three to six. In European specimens the dorsal margin of the achenes is more or less crenulate or rarely spined, but this character is not strongly marked in the New Zealand specimens. A plant with the achenes more than three in a fascicle may safely be referred to *Zannichellia*; rarely, owing to suppression, the achenes may be reduced to three or two, when the genus must be determined by the monœcious or diœcious habit. The cotyledon is twice folded in *Zannichellia*.

The only habitats in which *Z. palustris* has at present been observed in the colony are Mercer, Rangiriri, and other places in the Lower Waikato; Waikaremoana, Whangape, and Waihi Lakes: *T. Kirk*. East Cape district: *W. Colenso* (Handbook). Makararoa Stream, Hawke's Bay: *T. K.* Waikouaiti Lagoon, Otago: *D. Petrie*!

The only species observed in the colony is *Z. palustris*, which varies considerably in the shape of the fruits and the length of the styles. The Rangiriri plant has rather turgid, almost sessile carpels, which closely approach the form known in Europe as *Z. polycarpa*, but the styles are longer; usually the carpels are carried on short pedicels.

*Lepilæna* is characterized by diœcious flowers, the males solitary in the axils of the leaves, and consisting of three, or rarely two, sessile anthers, each seated in a minute perianth at the apex of a very short peduncle, the whole invested by the dilated and sheathing bases of two opposite leaves. The anthers are two-celled; the cells opening by slits on the outer face, and are monadelphous, cohering dorsally, so that they resemble a six-celled anther. The pollen is produced in great profusion, and appears to be discharged in the water before the full development of the female flowers; but further observations are required on this point. The female flower consists of three free carpels, which may be sessile or shortly stipitate: they spring from the apex of a very short peduncle with minute teeth. The perianth consists of three membranous bracts, and is closely invested by the dilated and scarious bases of the floral leaves. The fruits are three in number, rarely two; sessile, or on rather long pedicels, usually with long slender styles: the dorsal margin is quite entire.

*L. preissii*, F. Mueller, has only been found in the Waikato River near Churchill, where it occurred in considerable quantity and in great luxuriance, some of the slender stems exceeding 18in. in length. As it was late in the season (24th April) when collected, only fruiting specimens were obtained, with two or three imperfect female flowers. The male flowers have not been observed.

In 1881 I discovered another species in the Canterbury District, and recorded it under the name of *L. biloculata* in the report of the School of Agriculture, Lincoln, 1884 (second term). As will be seen from the appended description, it differs in several important particulars from any other species.

*Lepilæna bilocularis*, T. Kirk, in Report of Sch. of Agric., Lincoln, 1884.

Stems much branched, capillary, 3in. – 12in. long. Leaves flat, slightly broader than the stem, linear, one-nerved, obtuse. Male flowers enclosed in the dilated sheathing-bases of two opposite floral leaves. Anther solitary, sessile, on a short three-toothed peduncle, broad, connective produced, acute, the anther dehiscing from the apex. Female flower: perianth of three lanceolate membranous bracts at the apex of a short peduncle, carpels three, sessile, styles equalling or exceeding the perianth, stigmas dilated; reflexed, deeply fimbriate, exserted. Achenes three, rarely two; dorsal margin entire, style more than half the length of the achene, usually straight.

South Island.—Canterbury—drains and streams running into the Selwyn. In a small stream near the outlet of Lake Ellesmere: *T. Kirk*. Otago—Waihola Lake: *D. Petrie!*

The leaf-bases enclosing the male flowers are developed to a remarkable extent, the upper free portion on each side of the leaf presenting a stipular appearance, and appears to be composed of two (or perhaps three) membranous bracts adnate with the bases of the floral leaves. The leaf-bases investing the female flowers are much smaller.

The plant exhibits a departure from the usual characters of the genus—(1) In the large solitary anther which dehisces from the apex downwards, the cells diverging laterally; (2) in the produced connective; (3) in the reflexed and almost laciniate stigmas, which are very conspicuous.

Submerged aquatic plants have received little attention from New Zealand botanists, although it can hardly be doubted that other species will reward careful search.

## ART. XLIX.—*On the Products of a Ballast-heap.*

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

DURING the summer and autumn of 1892 and 1893 attention was drawn to the introduction of injurious weeds in earth-ballast, as exemplified by the introduction of the cockle-burr* (*Xanthium strumarium*, L.), in the ballast of the ship "Silver-stream" from Buenos Ayres, which had been temporarily deposited near the Bunny Street entrance to the railway goods-station, Wellington. As the total number of species exceeded one hundred, and 20 per cent. of them were new to the colony, it seems advisable to record this short chapter in the history of the introduction of exotic plants in New Zealand at some length, more especially as the great majority of the newcomers are of South American origin, and hitherto less than a dozen of our naturalised plants have come from that part of the globe.

The ballast, of which some portion had been removed when I first saw it, originally covered an area of about 40ft. in breadth by 70ft. or 80ft. in length, with a general height of 3ft. or 4ft. It had been clothed with a dense weedy growth, which had been cut down by the railway authorities, who learned the possibility of some of the plants proving noxious from the newspapers of the day. The ballast itself consisted chiefly of soil from cultivated land sparingly mixed with fragments of brick and other building rubbish. Portions of the earth were distributed some yards beyond the original area during its removal for the formation of a new platform at the passenger-station, so that certain of the plants were scattered for some distance along the line of removal. Although the soil was removed so closely that the old surface was laid bare in most places, numerous seed-containing particles were left behind, when several plants which had not been previously observed made their appearance for the first time.

The total number of plants collected is 104, of which about seventy belong to the great army of combatant weeds which have now become distributed along the great lines of ocean-travel all round the earth, and for the most part appear to find little difficulty in establishing themselves and encroaching upon their indigenous congeners when once introduced:

* See Trans. N.Z. Inst., xxvi. (1893), 310.

these do not enter into the scope of this paper to any material extent. Attention must be directed specially to the twenty species not hitherto observed in the colony, and to the few not previously known to occur in the Wellington Provincial District.

In October, 1893, after the removal of the ballast, the newly-pared surface soon became clothed with a robust growth of the purslane, *Portulaca oleracea*, *Chenopodium ambrosioides*, *Panicum crus-galli*, and other plants not previously seen under spontaneous conditions in Wellington. From its bright-yellow flowers, which were produced in great abundance, the purslane was remarkably prominent; but, as its showy corollas invariably closed immediately after the hour of noon, the dull appearance of the area in the afternoon formed a remarkable contrast with its morning brightness. Amongst these plants were others of great rarity, although very inconspicuous: *Petunia parviflora*, *Euphorbia ovalifolia*, *Roubieva multifida*, *Nicotiana acutiflora*, *Eragrostis minor*, *Acicarpha tribuloides*, *Setaria imberbis*, nearly all of which are natives of South America. Scarcely any of these were to be seen before the ballast was removed. Amongst the plants of the first year were *Chenopodium ficifolium*, *Emex australis*, *Alternanthera sessilis*, *Galinsoga parviflora*, *Echium plantagineum*, *Cenia turbinata*, *Bowlesia tenera*, *Cichorium endivium*, none of which made their appearance the second year except the *Chenopodium*, which occurred in some quantity, and was represented by a few straggling specimens last year, although not a scrap is to be seen at this date. In all probability the soil would still be productive if slightly broken up to the depth of a few inches.

*Xanthium strumarium* made its appearance the first year, numerous specimens were observed during the second year, and four or five were seen last year. When growing on the stiff clay it assumed a stout, robust appearance, differing widely from its usual appearance in Europe. None of the Wellington specimens exhibited the luxuriance shown by those of Australian growth, and, as it does not develope flowers and fruit until March and April, it is scarcely probable that it will become permanently established in this part of the colony. It would doubtless have a more favourable chance on the light soils of the Auckland Isthmus. *Roubirva multifida* assumed a very robust growth, and there seemed some probability of its being able to maintain its existence, although it failed to ripen seeds, as several strong plants were growing at the commencement of March, but most of them disappeared during the winter months, probably from injuries caused by cattle quite as much as by the severe frost. As the area is now mostly covered with a thick growth of common weeds, intermixed with patches of cocksfoot, meadow-grass, and rye-grass, there is but little probability of the rarer species again making their

appearance unless the surface should be disturbed. The species still to be found, although in small quantity only, are *Erodium malacoides* and *Chenopodium ambrosioides*, of each of which a few specimens are making a good fight against the coarser weeds; *Petunia parviflora*, now represented by three small plants only; and the plant here identified as *Aster imbricatus*, which has increased to a small extent: it may be expected to become permanent, together with the *Erodium*, although the latter is too much at the mercy of accident.

Amongst the plants developed on the ballast are three indigenous to New Zealand, although extending to other countries. *Dichondra repens*, Forst., made its appearance in small quantity during the first year, but plentifully the second year, and in small quantity last year; this year it is not in evidence. It has a wide distribution in temperate and extratropical countries in the Southern Hemisphere, so that its reintroduction from South America is not a matter for surprise. Another species, *Cotula coronopifolia*, is still more widely distributed, as it extends to Europe, and occurs in a naturalised condition in the British Islands: its range appears to be extending.

*Cotula australis*, Hook, f., has, however, a more limited distribution, being apparently confined to New Zealand, Australia, and Tristan d'Acunha. Unless, like its congener, *C. coronopifolia*, it is becoming naturalised in distant countries, the seeds must have been mixed with the ballast in Wellington, although this is somewhat improbable.

*Emex australis* did not appear after the first year. This South African plant requires a warmer climate than that of Wellington. In Queensland and other tropical countries it has become a great pest: on two occasions it made its appearance in the Auckland District, but did not prove permanent.

I append a list of the plants collected on the ballast and on the soil where it was deposited during the last three years:—

Note.—Species not previously observed in the colony are distinguished thus (*), and those not previously observed in the Wellington Provincial District thus (†).

### Fumariaceæ.

Fumaria muralis, *Sonder*.

### Cruciferæ.

Barbarea præcox, *R. Br.*
Sisymbrium officinale, *L.*
Brassica napus, *L.*
Capsella bursa-pastoris, *DC.*
Senebiera coronopus, *Poiret.*
" didyma, *Pers.*
Lepidium ruderale, *L.*

### Caryophyllaceæ.

Silene anglica, *L.*, *var.* quinquevulnera.
Cerastium triviale, *Link.*
Stellaria media, *L.*
Spergula arvensis, *L.*
Spergularia rubra, *St. Hilaire.*
Polycarpon tetraphyllum, *L.*

### Portulaceæ.

†Portulaca oleracea, *L.* Naturalised in Auckland.

### Malvaceæ.

Malva parviflora, *L.*
Modiola multifida, *Mœnch.*

### Geraniaceæ.

†Erodium malacoides, *Willd.* Naturalised at the Bay of Islands, 1867, but not observed elsewhere.

### Leguminosæ.

Ulex europæus, *L.* Only two plants observed.
Medicago sativa, *L.*
„ lupulina, *L.*
„ denticulata, *Willd.*
Melilotus arvensis, *Wall.*
Trifolium repens, *L.*
„ minus, *Sm.*
„ resupinatum, *L.*

### Umbelliferæ.

*Bowlesia tenera, *Spreng.* Monte Video, Brazil, &c.
†Apium leptophyllum, *F. Muell.*
Fœniculum vulgare, *Gært.*

### Rubiaceæ.

Sherardia arvensis, *L.*

### Calycereæ.

*Acicarpha tribuloides, *Juss.* Buenos Ayres.

### Compositæ.

*Aster imbricatus, *Walp.*
Erigeron canadensis, *L.*
†Erigeron linifolius, *Willd.* Naturalised in Auckland and Nelson.
*Gnaphalium purpureum, *L.* Florida, Carolina, &c.
„ luteo-album, *L.*
*Xanthium strumarium, *L.* Naturalised in most warm countries; but, although numerous specimens made their appearance, very few seeds, if any, were perfected, and the plant has died out.

Xanthium spinosum, *L.*
*Pascalia glauca, *Ontega.* In various parts of South America. Only two specimens observed on the ballast.
*Galinsoga parviflora, *Cav.* Monte Video, Brazil, &c.
Anthemis cotula, *L.*
Chrysanthemum inodorum, *L.*
Cotula coronopifolia, *L.* Indigenous in New Zealand, also in South Africa, extra-tropical South America, and some parts of Europe.
Cotula australis, *Hook. f.* New Zealand, Australia, and Tristan d'Acunha; so that it must either be naturalised in Monte Video or seeds must have become mixed with the ballast in Wellington.
*Cenia turbinata, *Pers.* Cape of Good Hope. This also appears to have become established at Monte Video. Only a few specimens observed on the ballast.
Senecio vulgaris, *L.*
Cryptostemma calendulacea, *R. Br.*
Cnicus lanceolatus, *L.*
*Cichorium endivium, *Willd.* Originally from eastern and northern India, but now established in many warm countries. Only a few specimens noticed.
Lapsana communis, *L.*
Picris echioides, *L.*
Crepis virens, *L.*
Leontodon hispidus, *L.*
Hypochæris radicata, *L.*
*Sonchus asper, *Hoffm.*

PRIMULACEÆ.

Anagallis arvensis, *L.*
" var. cærulea.

BORAGINEÆ.

†Echium plantagineum, *L.* A few specimens were observed, but the showy flowers were so attractive that they were speedily plucked, and the plant died out. Naturalised in Auckland.

CONVOLVULACEÆ.

Dichondra repens, *Forster.* Identified in the absence of flowers. A native of New Zealand, but found also in many parts of South America.

SOLANACEÆ.

*Nicotiana acutiflora, *St. Hil.* Brazil. Only a few specimens seen.
*Petunia parviflora, *Juss.* South Brazil, Monte Video, &c. Only a few specimens seen.

SCROPHULARINEÆ.

Verbascum blattaria, *L.*
Veronica arvensis, *L.*

PLANTAGINEÆ.

Plantago major, *L.*
" lanceolata, *L.*

AMARANTHACEÆ.

*Amaranthus deflexus, *L.* Europe.
†Alternanthera sessilis, *R. Br.* Indigenous on the Auckland Peninsula. Found in many tropical and extra-tropical countries.

CHENOPODIACEÆ.

Chenopodium album, *L.*
* " ficifolium, *L.* In great abundance (Europe).
" murale, *L.*
†Chenopodium ambrosioides, *L.* Possibly indigenous on the Auckland Peninsula and in Taranaki, but not previously observed in Wellington.
*Roubieva multifida, *Moq.* Buenos Ayres, Brazil, &c.
Atriplex deltoidea, *Bab.*

POLYGONACEÆ.

Polygonum convolvulus, *L.*
Rumex pulcher, *L.*
" obtusifolius.
" sanguineus, *L.*, var. viridis.
" acetosella, *L.*
†Emex australis, *Stein.* South Africa. Naturalised in many warm countries. Has been collected in Auckland and Tauranga, but soon dies out.

EUPHORBIACEÆ.

Euphorbia peplus, L.
* " ovalifolia, *Engl.* Chili, Mendoza, Monte Video, &c.

URTICACEÆ.

Urtica urens, *L.*

CYPERACEÆ.

Cyperus vegetus, *Willd.*

GRAMINEÆ.

*Paspalum dilatatum, *Poir.* Brazil, &c.
Panicum sanguinale, *L.*
†Panicum colonum, *L.* Naturalised in Auckland, but very rare at present.
†Panicum crus-galli, *L.* This was very plentiful, but has completely died out. It is naturalised in Auckland.
*Setaria imberbis, *R. et S.*

Phalaris canariensis, *L.*
Avena sativa, *L.*
" strigosa, *Schreb.*
Cynodon dactylon, *L.*
*Eleusine coracana, *Gært.* Monte Video, Brazil, &c.
*Eragrostis minor, *Host.* Brazil, La Plata, &c.
Dactylis glomerata, *L.*
Briza minor, *L.*
Poa annua, *L.*
†Glyceria rigida, *Sm.* Hawke's Bay, Otago, &c.
Bromus unioloides, *DC.*
" sterilis, *L.*
* " vestitus, *Thunb.* South Africa.
Lolium perenne, *L.*
" italicum, *A. Br.*
" temulentum, *L.*
Lepturus incurvatus, *L.*
Hordeum murinum, *L.*

I am indebted to the Director of the Royal Gardens, Kew, for the authentication of most of the South American species.

NOTE.—As this paper was written in September, it may be advisable to state that the position of several of the surviving species has somewhat improved during the interval. *Aster imbricatus* has increased to a considerable extent, and *Chenopodium ambrosioides* is more plentiful. *Roubieva multifida* must have produced perfect seeds, as it has increased considerably, although I failed to detect them; several plants of *Petunia parviflora* have made their appearance; and there are about a score specimens of *Chenopodium ficifolium;* while the old plants of *Pascalia glauca* have developed new stems, which seem likely to produce flowers in April.

It will be remembered that the ballast was used in the formation of a platform at the passenger-station. The surface of the platform has been covered with asphalt; but beyond the asphalted portion I found three specimens of *Pascalia*, and in the immediate vicinity several plants of *Roubieva* and *Chenopodium ficifolium.* Should the platform be broken up during the twentieth century, most of the plants enumerated in the list will doubtless make their appearance in profusion.

1st March, 1896.

### ART. L.—*Notice of the Occurrence of an Undescribed Palm-lily on the Auckland Peninsula.*

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

THE special interest attached to the arborescent *Liliaceæ* of the colony will, I doubt not, be a sufficient apology for drawing attention to the existence in the extreme north of an undescribed plant belonging to this group, although but little can be said respecting it beyond the fact of its occurrence. At present it is not possible to determine whether it should be referred to *Cordyline* or *Dracæna*, or possibly enough to some other genus; but it is only by publishing the facts as far as known that attention can be drawn to the plant, and specimens obtained for identification.

About three years ago Mr. John Maxwell sent the upper part of a leaf of what appeared to be a species of *Cordyline* or *Dracæna*, informing me that the plant from which it had been taken was growing in the garden of Mr. Reid, Ahipara, and that it had been found in the forest near that settlement. On applying to Mr. Reid, that gentleman most obligingly forwarded a complete leaf, and stated that he had two plants under cultivation, both of which were obtained from the bush on the face of a cliff, about 200ft. above sea-level; the flowers and fruit were quite unknown. He promised to search for the mass of tree-roots, which I am glad to say is still living under plant, and inform me of the result. Subsequently I received a living plant, which had evidently been dug from amongst a cultivation, although it has made no growth at present. Recently I learned that it was forwarded by a young lady, who unfortunately did not favour me with any information as to the conditions under which the plant was found.

The blade of the leaf sent by Mr. Reid is exactly 18in. long by 5½in. broad at its widest part; it is almost elliptic-oblong in shape, although the upper half is slightly broader than the lower; the apex is rather abruptly acute, and the base is gradually narrowed into the petiole, which is fully ½in. broad on the flattened upper surface, and convex beneath, with a broad wing along each margin for its entire length of 4in. The abruptness with which the petiole is narrowed into the midrib is very remarkable; the midrib is extremely slender, and is continued to the point of the leaf, being scarcely more than a mere line in the upper part; the innumerable nerves being given off along its entire course. In

texture the leaf approaches that of *Cordyline banksii*, but is more membranous.

I entertain the hope that specimens of the flowers and fruit may be obtained in time to allow of its being described in the "Student's Flora," and venture to ask the assistance of any resident in the district who may be interested in natural-history pursuits towards realising this object.

It affords me pleasure to name this plant provisionally *Cordyline cheesemanii*, as an acknowledgment of my obligation to Mr. Cheeseman for his excellent botanical work.

I venture to remonstrate against the use of the unmeaning name "cabbage-tree" applied by many settlers to the various species of *Cordyline*. It may be too much to expect that the native names, "ti," "ti kapu," "ti koraha," &c., should come into general use, but surely the most appropriate name, "palm-lily," for which we are indebted to the learned Baron von Mueller, is sufficiently elegant and euphonious to be generally adopted.

May I be permitted another digression? I am convinced that much has yet to be done in working up the plants of the district to the north of Whangape and Mongonui. The Cunninghams' exploration scarcely extended so far north. Mr. Colenso visited the district in very early times, nearly fifty years ago, when he discovered *Lycopodium drummondii*, which has not been found by any later collector. Buchanan's visit to the district in 1865–66 was of a somewhat cursory character, my own visit in 1867 was restricted to a few days during the early winter; yet a few novelties were found by both of us even under such disadvantageous conditions. *Ozothamnus lanceolatus*, discovered by Mr. Buchanan, and *Kyllinga monocephala*, detected near Mongonui by Mr. Ball, have not been observed by others. There can be no doubt that a careful examination of the district from Whangape and Mongonui northward would be attended with gratifying results. It has long been known as the home of several plants of a tropical or subtropical character, such as *Hibiscus diversifolius*, *Ipomœa palmata*, *Cassytha paniculata*, *Pisonia umbellifera*, &c. It would be of great assistance to New Zealand botanists if some of the intelligent settlers of the district could be induced to assist in the work.

## Art. LI.—*A Revision of the New Zealand Species of* Hymenanthera, *R. Br.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

Hymenanthera was first published by R. Brown in his account of the botany of the Congo appended to Tucker's narrative of his expedition. Two plants in the Banksian Herbarium were named by him *H. dentata* and *H. angustifolia* respectively, but the descriptions were first published by De Candolle in 1824 (Prodr., i., 315); the former was characterized by its oblong denticulate leaves, the latter by its entire linear leaves: both are now united under *H. dentata* by the common consent of botanists. In 1833 Endlicher described *H. latifolia* from Norfolk Island; and in 1842 A. Cunningham described *H. oblongifolia*, which is now referred to *H. dentata*. The first New Zealand species was discovered by Banks and Solander in 1769, probably in Queen Charlotte Sound, but was completely lost until 1876, when it was rediscovered by J. D. Enys and the writer, who described it under the name of *H. obovata* in 1894. The first-described New Zealand species was discovered by R. Cunningham, on the coast opposite the Cavallos Islands, in 1834; his specimens, however, were imperfect, and the plant was published by A. Cunningham in his Precursor as *Scævola* (?) *novæ-zealandiæ*; it was not until 1853 that the plant was properly understood and described by Sir Joseph Hooker as *Hymenanthera crassifolia*, the value of the excellent description being enhanced by the beautiful plate which accompanied it. Another New Zealand species was described by J. Buchanan as *H. traversii* in 1882, and the Australian *H. dentata* was collected in the Southern Alps about the same time. *H. latifolia* of Norfolk Island had been discovered on the Great and Little Barrier Islands by the writer six years earlier. Another species, discovered on the Chatham Islands by Captain Gilbert Mair, was referred by Baron von Mueller to *H. latifolia* as a variety in 1864, but in this paper is treated as a distinct species. A synopsis of the distinctive characters of each is appended.

*Hymenanthera* comprises sparingly-branched shrubs which are usually erect, and others which are excessively branched and most frequently depressed; the branches of the latter are sometimes naked, divaricating, rigid, and spinous, with pale or brownish bark which is often closely dotted with lenticels. The leaves are alternate or sometimes fascicled, entire or denticulate or serrate, petioled, usually coriaceous or rarely

membranous; the stipules are usually small and fugacious. The flowers are hermaphrodite or diœcious; solitary, or more usually fasciculate and shortly pedicellate, rarely solitary; they are rarely produced in the axils of the leaves, most frequently on the naked parts of the branches. The sepals and petals are obtuse or rounded at their apices, or the petals may be narrowed above and shortly revolute. The andrœcium consists of five sessile anthers which open longitudinally and form a ring surrounding the style; their connectives are, however, connate, and are produced into a rounded or subacute ciliated membrane above each anther, with a curious obovate dorsal appendage. The ciliated processes and their dorsal appendages vary in shape in the different species, but not sufficiently to afford distinctive characters. Stigmas 2, rarely 4 or 3, divergent, styles very short. The fruit is a spherical 1-celled berry of a deep purple colour, or rarely white. The seeds are 2 in number, rarely 4, 3 or sometimes solitary by abortion; they may be ovoid, plano-convex, or convex and pointed with one or two angular faces at the base and a strophiole which may be very slightly developed or large and distinctly cupular. The cotyledons are orbicular in all the seeds examined by me. The most important differential characters are those afforded by the seeds taken in conjunction with the leaves.

Baron von Mueller appears to have been the first to draw attention to the plano-convex form of fruit (Plant. Vict., i., 69), but did not attach to it the importance which it seems to me to merit.

It will be seen that *H. dentata*, R. Br., is only represented by its variety *angustifolia;* I have seen nothing in the colony approaching var. *oblongifolia* of Norfolk Island, in which the denticulate leaf is over 1½in. long, and I have not had the opportunity of examining Norfolk Island specimens of *H. latifolia*. The New Zealand plant, which is only known in a fruiting condition, was kindly examined for me by the director of the Royal Gardens, Kew, in 1876, and referred to *H. latifolia* var.; but the differences do not appear to be sufficiently marked to render it worthy of special distinction. Mr. Cheeseman sends a sterile leafy specimen from the Three Kings Islands, characterized by more strict slender branchlets and oblong or oblong-ovate leaves with obscurely sinuate-dentate revolute margins and slender petioles. The leaves are of thinner texture than in *H. latifolia*, and the reticulations on both surfaces are not so strongly marked.

1. **H. crassifolia**, Hook. f. Fl. N.Z., i., 17, t. 8.

A low rigid spreading shrub, with short stout tortuous branches, bark white, furrowed, branchlets pubescent. Leaves

alternate or fascicled, very coriaceous, linear, spathulate, or linear-obovate, ¼in.–1¼in. long, entire or sinuate, toothed or lobed, rounded or retuse, petioles very short. Flowers small, axillary, solitary or in small fascicles; peduncles shorter than the flowers, curved, with two ovate bracts below the middle. Sepals much shorter than the petals, minutely erose; petals linear oblong, recurved at the apex. Anthers forming a tube round the ovary, connective fimbriate with a dorsal scale. Ovary 1-celled, placentas 2. Berry purple or white, 2-seeded. Seeds 2, convex on the outer face. Handbook, 18. *Scævola* (?) *novæ-zealandiæ*, A. Cunn., Precurs., n. 429.

North Island.—Maritime rocks opposite the Cavallos Islands: *R. Cunningham*. Northern shore of Cook Strait, from Cape Terawhiti to Cape Palliser, &c.; Port Nicholson: *T. Kirk*.

South Island.—Nelson: Coast between the Boulder Bank and Croixelles Harbour: *T. Kirk*. Marlborough: Pelorus Sound, &c.: *J. Rutland!* Canterbury, Coast of Banks Peninsula: *J. B. Armstrong!* Otago: *D. Petrie*.

Stewart Island.—*T. Kirk*. October, November.

Erect shoots with broader leaves are sometimes developed in sheltered situations.

2. **H. dentata**, R. Br., var. **angustifolia**, Benth. Fl. Austr., i., 104.

An excessively branched shrub, 2ft.–8ft. high; branchlets terete, imbricate, about as thick as whipcord, often naked and spinescent, closely dotted with minute lenticels. Leaves on very short petioles, often fascicled, narrow linear-oblong, cuneate at the base, rather membranous or subcoriaceous, entire or sinuate or shortly lobed, rounded at the apex, ¼in.–¾in. long. Flowers perfect or diœcious, almost sessile, solitary or geminate. Male flower not seen. Female almost sessile, petals narrow, anthers abortive, style short, stigmas 2, spreading. Berry 2-seeded, seeds oblong, flat on the inner face, convex on the outer, with a small discoid strophiole. Hook., Comp. to Bot. Mag., i., 274; Hook. f., Fl. Tasm, i., 27; *H. angustifolia*, R. Br., in DC. Prodr., i., 315; *H. banksii*, F. Muell., Pl. Vict., i., 69.

North Island.—Wellington: Turangarere; *A. Hamilton!* Upper Rangitikei; *D. Petrie!*

South Island.—Nelson: Wairoa North: *W. H. Bryant* and *T. Kirk*. Canterbury: Alps: *J. B. Armstrong!* Otago: Paradise, Mount Earnslaw, *T. Kirk*; Kelso, *D. Petrie*.

Easily distinguished by the lenticellate bark, slender twigs which are flexuous when grown in sheltered conditions, and the diœcious flowers. The Tasmanian plant is said to produce hermaphrodite flowers. At present I have only had the op-

portunity of examining the female flowers of the New Zealand plant.

Var. **alpina.**

Depressed, 1ft.–2ft. high, branches very short, rigid, stout, usually terminating in stout spine. Bark whitish, lenticellate. Leaves less than ½in. long, usually fascicled, very coriaceous, oblong-obovate, petiole very short. Flowers on very short straight peduncles. Sepals erosulate-ciliate. Petals broad, recurved. Anthers very broad, connective, much produced, nearly entire, dorsal scale broadly cuneate. Style slender, stigmas 2, spreading. Berry white, 1–2-seeded; the former ovoid with a minute discoid strophiole; the latter with the inner faces flattened at the base but not angled.

South Island.—Alps of Canterbury and Otago; 2,000ft.–4,000ft. A remarkable plant, forming a mass of very short stout spinous branches. Possibly a distinct species. December, January.

3. **H. obovata,** T. Kirk; in Trans. N.Z. Inst., xxvii. (1894), 350.

An erect glabrous shrub, 4ft.–8ft. high, branches few, slender, ascending; bark pale. Leaves in the young state obovate-cuneate, 3-lobed or -toothed, membranous, mature, very coriaceous, 1in.–2in. long, obovate or oblong, narrowed into a slender petiole below, rounded or retuse above, rarely apiculate, margins slightly recurved, rarely entire. Flowers, male not seen. Female sepals broadly ovate, rounded at apex. Ovary 2-celled; stigmas 2. Fruit solitary or twin, on very short curved peduncles; ovoid, purple, 2-seeded. Seeds nearly ovate, slightly concave on the inner face, convex on the outer; strophiole cupular, thin.

South Island.—*J. Buchanan!* Nelson: Graham River, Mount Owen, *T. F. Cheeseman!* between Takaka and Riwaka, *T. Kirk.* Marlborough: Queen Charlotte Sound, *J. H. Macmahon!* Canterbury: Broken River basin, *J. D. Enys* and *T. Kirk* (1876); Ashburton Mountains, *T. H. Potts!* Chiefly on limestone rocks, 2,000ft.–4,000ft.

The rather slender branches and the strict habit distinguish this species from all others at sight.

4. **H. traversii,** J. Buchanan; in Trans. N.Z. Inst., xv. (1882), 339, t. 28.

A spreading shrub, 1ft.–2ft. high, twigs with reddish longitudinal rugose bark, viscid when fresh. Leaves rather crowded, coriaceous, oblong-obovate or oblong-spathulate, about 1in. long, narrowed into a rather stout appressed petiole, obtuse or sub-acute, margins recurved, nerves

obscure. Flowers few, solitary, on short decurved pedicels in the axils of the upper leaves. Sepals coherent at the base, subacute. Petals linear, oblong, narrowed below, spreading. Fruit not seen.

South Island.—Nelson: In the forest, Gouland Downs, near Collingwood: *H. H. Travers.*

My knowledge of this plant is confined to Mr. Buchanan's description, and a small flowerless specimen, for which I am indebted to him. It is distinguished from all other species by the red bark and rugose leaves with appressed peduncles. Good specimens in flower and fruit are much to be desired, as the anthers and ovary are not mentioned in the original description.

5. **H. latifolia,** Endlicher; in Fl. Insul. Prodr. Norf., n. 127.

A sparingly-branched shrub, 2ft.-10ft. high, erect or straggling. Leaves ovate-lanceolate, or oblong-lanceolate narrowed into the petiole, 2in.-4in. long, 1in. broad, obtuse, coriaceous, entire, sinuate or sinuate-serrate, marginal nerve stout. Flowers not seen. Sepals ovate, in the fruiting state scarcely coherent at the base. Fruiting peduncles very short, erect or curved. Berry 2-seeded; seeds ovoid, flat on the inner face, with irregular longitudinal striæ on the outer convex surface. Strophiole large, cupular.

North Island.—Auckland: Tapotopoto Bay, *T. Kirk;* Mount Camel, *J. Buchanan;* Whangapoua and Flat Island, Great Barrier Island; Arid Island, *T. Kirk;* Three Kings Islands, *T. F. Cheeseman.* Littoral. Also on Norfolk Island.

The New Zealand plant has not been seen in flower. Endlicher describes the female flower of the Norfolk Island plant as having abortive or perfect stamens. He also states that the ovary is 2-celled and the stigma capitate, both of which appear to be erroneous. The leaves are strongly reticulate on both surfaces.

6. **H. chathamica,** n.s.

An erect shrub, with furrowed lenticellate bark. Leaves lanceolate or oblong-lanceolate, narrowed at the base, acute, 3in.-5in. long, ¾in.-1¼in. broad, very coriaceous, strongly reticulate on both surfaces, sharply toothed. Flowers in crowded fascicles, diœcious, pedicels slender, longer than the flowers, decurved. Sepals coherent at the base, narrow, ovate. Petals very long, obovate with a broad base, revolute at the apex. Anthers with a narrow lanceolate jagged connective, more than half as long as the anther-cells; dorsal gland cuneate-spathulate, rounded above. Female flowers not seen. Berry ovoid or almost globose, white; stigmas 4-lobed; 4- rarely 3-seeded, seeds angled, curved towards the point,

convex on the outer surface; strophiole very small. *H. latifolia*, var. *chathamica*, F. Mueller, Veg. Chat. Islds., 9.

North Island.—Wellington: Patea: *Sir James Hector*. Flowers and fruit not seen.

Chatham Islands.—Originally discovered by *Captain Gilbert Mair!* September, October.

Distinguished from all other species by the long lanceolate sharply-toothed leaves, strictly diœcious flowers, tetramerous stigma-lobes, and 4-seeded berries. Occasionally the leaves are linear-laceolate, and less than ¼in. in breadth. I am indebted to my friend Mr. Cox for excellent specimens of the male plant.

## ART. LII.—*Notes on Certain Veronicas, and Descriptions of New Species.*

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

IT is not proposed to offer a complete revision of the New Zealand Veronicas on the present occasion, although it is hoped that this much-needed work may be accomplished in a short time. It is, however, desirable to supplement the published descriptions of certain species from more copious material than was available when they were originally drawn; to amend certain errors that crept in from the examination of imperfect specimens; and to describe a few new species, most of which have been in hand for some years past.

With the full revision it is intended to furnish an account of the most striking characteristics of the New Zealand species generally, more especially with regard to their morphology and distribution. It may, however, be pointed out that the species of the dimorphic—or, as it might with equal propriety be called, the mimetic—section are invested with special interest, the entire section, with the single exception of the Australian *V. densifolia*, being endemic in the colony. At present, strangely enough, our knowledge of the early leaves of these singular plants has been chiefly obtained from old specimens on which they are often produced by reversion, especially under cultivation: the subject will not be satisfactorily worked out until the seedling as well as the more advanced stages have been studied in a systematic manner.*

* For the first recorded mention of dimorphism in the leaves of New Zealand Veronicas, see Trans. N.Z. Inst., xi. (1878), 464.

Mr. N. E. Brown, of Kew, was the first to point out that most of the plants referred in the Handbook and the "Transactions of the New Zealand Institute" to *Logania* and *Mitrasacme* were true Veronicas. To the botanist acquainted with the subalpine and alpine vegetation of New Zealand it seems the most natural mistake in the world that flowerless specimens of *Veronica tetragona* should be referred to *Podocarpus* or *Dacrydium* when examined without reference to their minute structure, while the general aspect of one or two others, coupled with tetrandrous or pentaphyllous flowers, equally accounts for their reference to *Logania* on the examination of specimens destitute of fruits, or at best with fruits in an immature condition. The reference of others to *Mitrasacme* is unquestionably due to an oversight arising from the severe physical pain under which the describer laboured during the progress of his work.

*Veronica canescens*, T. Kirk, in Trans. N.Z. Inst., ix. (1876), 503, t. xix., f. 2.

Limb of corolla spreading at maturity; lobes broad, rounded at the tips, the uppermost longer than the others. Capsule wholly included within the calyx, broadly ovoid, slightly compressed, retuse.

South Island: Canterbury—Lake Forsyth, *T. K.*; Lake Lyndon, *J. D. Enys* and *T. Kirk*. Otago—Oamaru, *J. Buchanan;* Maniototo Plains, *D. Petrie*, *T. Kirk;* Wycliffe Bay, Dunedin, *B. C. Ashton!* Sea-level to 2,800ft., but remarkably local.

According to the Index Kewensis, the trivial name has been erroneously applied to three other species: *V.* "*canescens*," Bast., Fl. Maine et Loire, Supp. 21, is *V. teucrium*, L., Sp. Pl., ed. ii., 216; *V.* "*canescens*," Presl., *ex* Schult. Mant., i., Add. II., 229 = *V. prostrata*, L., Sp. Pl., ed. ii., 22; *V.* "*canescens*," Schrad., Comm. Veron. Spic., 19 = *V. incana*, L., Sp. Pl., 10: all natives of Europe.

*V. anagallis*, L., Sp. Pl., 12.

This has not been observed since it was collected by the Rev. W. Colenso in Hawke's Bay. As it is a plant that produces seeds in great abundance in Europe, it is not easy to account for its disappearance, even if it be assumed that Mr. Colenso's specimens were of exotic origin.

*V. hookeriana*, Walp., Rep., iii., 341.

This species extends over a wider area than is generally supposed, as it is found in the Ruahine Range (Colenso), Tongariro, Ngauruhoe, and is especially abundant on Ruapehu. I believe that it occurs on the Kaimanawa Range also, but

have not seen specimens. *V. nivea*, Hook., Ic. Pl., t. 640. *V. nivalis*, Hook. f., Fl. N.Z., i., 196; Handbk., 215.

*V. loganioides*, J. B. Armstrong, in Trans. N.Z. Inst., xiii. (1880), 359.

Leaves of young plants in rather distant pairs, linear-subulate, dilated at base and often toothed, spreading above; stems pubescent or tomentose. Calyx-lobes ovate-lanceolate, especially in the fruiting stage. Capsule broadly elliptical, equalling or slightly exceeding the calyx, didymous, turgid.

South Island: Canterbury—Rangitata Valley, *J. F. A.!* Clyde Valley, *W. Gray*.

Notwithstanding the suffruticose character of this rare plant, the didymous capsule shows that it is closely allied to the herbaceous section.

**V. erecta**, n. s.

Stems 6in.–10in. high, erect, strict, simple or sparingly branched from the base, glabrous or rarely puberulous. Leaves distant, sessile, oblong-lanceolate, acute, $\frac{3}{4}$in.–1in. long, membranous, patent, margins often puberulous or ciliate at the base, bark reddish-purple. Racemes 2–6 in the axils of the apical leaves, 3in.–4in. long, strict, erect or ascending, naked below. Flowers fascicled or solitary, often distant; rhachis pedicels and bracts puberulous or pubescent. Bracteoles exceeding the pedicels, ciliate. Calyx campanulate, divided for three-fourths of its length, segments ovate-lanceolate, subacute or acute, ciliate. Corolla-tube rather broad, shorter than the spreading limb, upper lobe broadly rounded, lower narrow acuminate, stamens exserted. Capsule ovate, oblong, acute, compressed, one-third longer than the sepals.

South Island: Otago—Believed to have been collected on Mount Bonpland, but the exact habitat uncertain.

A very distinct species, remarkable for the strict erect habit and elongated interrupted racemes with the flowers often fasciculate. It should be placed next to *V. raoulii*, Hook, f. Described from cultivated specimens kindly forwarded by Mr. Martin, nurseryman, of Green Island.

**V. petriei.**

Stems decumbent or prostrate, woody, 4in.–6in. long; branches ascending, 3in.–4in. long. Leaves $\frac{1}{4}$in.–$\frac{1}{3}$in. long, elliptical oblong, rounded at the apex, narrowed into a short broad petiole, membranous, glabrous or the margins glandular, ciliated; opposite petioles connate. Flowering branches densely clothed with foliaceous obtuse linear bracts, racemes terminal; flowers solitary, sessile, partially hidden in the axils

of crowded linear ciliated bracts, which slightly exceed the calyx. Calyx cleft to the base, lobes 4, linear, obtuse, ciliated, exceeding the corolla-tube; limb much shorter than the tube, lobes spreading or reflexed, the lower acute, the uppermost rounded; stamens 2, included; style long, slender. Capsule oblong, slightly turgid, seated in a cupular disk. *Mitrasacme petrici*, J. Buchanan, in Trans. N.Z. Inst., xiv. (1881), 350, t. xxx., f. 1.

South Island: Otago — Mount Bonpland, *D. Petrie!* 6,000ft.

The densely-crowded linear bracts easily distinguish this fine plant from all other New Zealand species. It is, perhaps, the most remarkable of the many plants added to the Otago flora by its energetic discoverer, to whom I am indebted for the only specimen I possess. The stems are really perfoliate.

*V. hulkeana*, F. Muell., *ex* Hook. f., Handbk., 213.

Bracts oblong, obtuse, shorter than the tubular calyx; corolla-lobes subacute. Capsule retuse and turgid when mature.

Sea-level to 3,000ft.

*Var.* **oblonga.**

Leaves narrow-oblong, fully 3in. long including the petiole, coarsely toothed.

South Island: Marlborough—Awatere; *T. Kirk.*

*Var. fairfieldii*, sp., Hook. f., Bot. Mag., t. 7323.

Flowers larger and more deeply coloured than in the type, panicle usually shorter and broader. Bracts glandular-pubescent, equalling or shorter than the spreading calyx, acute; calyx-lobes acute or subacute with scarious margins; lobes of corolla rounded at the apex.

South Island: Fairfield Downs.

The typical form was originally discovered by the Hon. F. Weld.

*V. macrantha*, Hook. f., Handbk., 213.

Sparingly branched, 1ft.–2ft. high. Leaves varying from oblong-ovate to obovate-lanceolate, thick and glossy. Calyx broadly ovate, acute, equalling or slightly exceeding the sepals. Corolla pure white.

South Island: Mountains of Nelson, Canterbury, and North Otago, but often local; 2,500ft.–4,000ft.

*V. haastii*, Hook. f., Handbk., 213.

Leaves imbricating, patent or deflexed, fleshy when fresh, very coriaceous when dry. Flowers in 2–6-flowered fascicles at the tips of the branches, forming an oblong head, much

hidden by the apical leaves; bracts equalling the sepals but broader, sepals linear-oblong, obtuse, corolla small, equalling the sepals, tubular, lobes acute. Capsule equalling or shorter than the calyx, ovate-oblong, acute, glabrous.

South Island: Nelson—Mount Arthur, &c., *Cheeseman, Bryant! Gibbs!* Canterbury—Mounts Darwin, Dobson, Torlesse, and Cook, source of the Waimakariri, *Haast!* Leith Hill, *Enys!* Otago—Mountains north-east of Lake Hawea; Mount Arnould; *D. Petrie!* 3,000ft.-6,000ft.

**V. dasyphylla.**

Stems rigid, woody, 1in.-3in. long, creeping at the base, branches with the leaves ¼in. diameter. Leaves closely quadrifariously imbricate, connate in pairs at the base, erect or spreading above, oblong-obovate, rounded above, ciliated below, sessile, very coriaceous. Flowers solitary, terminal, sunk amongst the apical leaves. Calyx divided nearly to the base, lobes oblong, obtuse, hispid pubescent below, ciliated. Corolla broadly funnel-shaped, tube broad, shorter than the limb, lobes 5, large, rounded, spreading. Stamens 2, filaments very short; style long, slender. Capsule oblong, seated in a cupular disk, rather turgid, much shorter than the calyx, slightly retuse. *Logania tetragona*, Hook. f., Handbk., 189 and 737; J. Buchanan, in Trans. N.Z. Inst., xiv. (1881), 347, t. xxviii., f. 2.

South Island: Nelson—Mount Arthur, &c., *W. H. Bryant!* Otago—West Coast Sounds, Lake District, and Mount Alta, *J. Buchanan!* Ben Lomond and Old Man Range, *D. Petrie!* 3,500ft.-5,000ft.

A small species, remarkable for the large terminal flower with its pentamerous calyx and corolla. All the flowers examined by me are diandrous. I am indebted to the Director of the Herbarium, Kew, for a small portion of the type-specimen.

**V. gilliesiana.**

A prostrate or suberect shrub, stems 1in.-6in. long, much branched, spreading, tetragonous, with the leaves ¼in.-½in. diameter. Leaves glabrous in the young state, lax, linear, pinnatifid; mature closely imbricating below, connate by the broad base, tips spreading, linear or linear-oblong, convex beneath, deeply concave above or rarely flat, rounded and very obtuse at the tip, margins ciliate. Flowers terminal or near the apex of a shoot, axillary, solitary or in 2-4-flowered umbels. Calyx deeply divided, lobes 4, oblong, ciliate; corolla funnel-shaped, tube shorter than the calyx, segments orbicular spreading, the uppermost much narrowed at the base; stamens 2 or rarely 4, filaments very

short, included, style scarcely exceeding the anthers. Capsule ovate-oblong, compressed laterally, seated in a cupular disk. *Logania ciliolata*, Hook. f., Handbk., 737. *Mitrasacme hookeri*, J. Buchanan, in Trans. N.Z. Inst., xiv. (1881), 348, t. xix., f. 1.*

South Island: Nelson—Amuri, *T. Kirk;* Mount Franklin, *F. G. Gibbs!* Canterbury—Browning's Pass and source of the Rangitata, *Sir Julius von Haast!* Arthur's Pass, *T. Kirk;* source of the Waimakariri, *J. B. Armstrong!* Power's country, *J. Hadrell!* Westland—Mountains opposite Jackson's, *L. Cockayne!* Otago—Mountains of the west coast, *J. Buchanan!* 3,000ft.–5,000ft.

Probably not infrequent in alpine situations. Specimens turn black when dried. This species varies to a considerable extent in the length of the mature leaves and diameter of the branches; the former range from $\frac{1}{8}$in.–$\frac{3}{8}$in., and except at the apex are usually deeply concave for their entire length. The same plant may produce both solitary and fasciculate flowers, but when all the flowers are solitary the floral leaf has a largely-developed membranous base, with the free portion reduced to a mere point or knot. Mr. Buchanan's drawing represents a large form in which the flowers are more distant from the apex of the branch than in the form with short leaves; but there is a great amount of variation in all these points. Tetrandrous flowers appear to be confined to plants with short leaves. I am indebted to Mr. Buchanan for specimens showing the young leaves.

I have dedicated this remarkable plant to the memory of my friend the late Mr. Justice Gillies, an enthusiastic naturalist, whose munificence to the Auckland Institute and University College should be long remembered.

*V. cupressoides*, Hook. f., Handbk., 212; Bot. Mag., t. 7343.

Leaves of the young state linear- or ovate-oblong, often cuneate below, acute, toothed, lobed or pinnatifid, narrowed into short petioles which are free at the base. Mature leaves $\frac{1}{20}$in.–$\frac{1}{18}$in. long, ovate-oblong, obtuse, opposite leaves connate at the base, patent or appressed above. Flowers very small, 2–8 at the tips of the branchlets forming a small oblong head, sessile or very shortly pedicellate. Bracts equalling the deeply 4-cleft calyx, sepals broadly ovate, obtuse; corolla-tube very short and broad, limb spreading, upper lobe linear, exceeding the others which are broad and rounded; filaments lengthening after anthesis. Capsule cuneate-oblong or ovate, retuse, turgid. *V. cupressoides*, var. *variabilis*, N. E. Brown,

* Mr. Buchanan's diagrams of the corolla and stamens of this and other species show the stamens opposite the petals instead of alternating with them.

in Gard. Chron., vol. iii. (1888), 21, figs. 5D, 5E, represents the young state. The corolla is white or pale-purple, never violet.

*V. armstrongii*, T. Kirk, in Trans. N.Z. Inst., xi. (1878), 464.

South Island: Alpine districts in Nelson, Westland, Canterbury, and Otago; 2,500ft.–4,500ft.

*V. tetrasticha*, Hook. f., Handbk., 211.

Stems 1in.–4in. long, excessively branched. Leaves in the young state linear subulate, slightly imbricated at the base and spreading above. The mature capsules are broadly obovate or pyriform, rounded at the apex and compressed, three times as long as the calyx.

South Island: Common in alpine situations in the Nelson District; less frequent in Canterbury; rare and local in Otago; 3,000ft.–5,000ft.

**V. tumida**, n. s.

Stems prostrate, forming compact depressed patches 6in.–24in. diameter; branchlets excessively numerous, 1in.–3in. long, strict, erect, obtusely quadrifarious, (with the leaves) $\frac{1}{18}$in.–$\frac{1}{12}$in. diameter. Leaves densely imbricate, about $\frac{1}{30}$in. long, tumid obtuse, deltoid above, cuneate at the base and slightly connate at the side, concave on the upper surface but almost keeled beneath. Flowers in terminal 2–4-flowered fascicles, sessile. Calyx minute, deeply 4-cleft, lobes linear oblong obtuse; corolla, minute ciliolate tube equalling the limb, lobes narrow, spreading; filaments as long as the rather broad anthers; ovary conical. Capsule suborbicular, compressed, rounded at the apex.

South Island: Nelson—Mount Rintoul and Ben Nevis, *F. G. Gibbs!* Mount Starvation, *W. H. Bryant!* Otago—*J. Buchanan!* 3,000ft.–4,500ft.

A singular plant, allied to *V. salicornioides* and *V. tetrasticha*, but distinguished from both by the tumid leaves, crowded shorter branches and broad capsules, from the former in addition by its quadrifarious branchlets.

**V. quadrifaria.**

An erect rigid shrub 3in.–8in. high, much branched, branches with the quadrifarious leaves $\frac{1}{10}$in. diameter. Leaves very coriaceous, most densely imbricated, ovate deltoid, connate and ciliate at the base. Flowers terminal in 4-flowered umbels, each consisting of 2 opposite pairs of bracteate pedicellate flowers. Calyx divided nearly to the base, lobes 4, linear, obtuse, ciliate, shorter than the ovate bracts; corolla tube equalling the calyx, lobes 4, rounded, spreading; stamens 2, on very short filaments, included; ovary narrow oblong;

seated in a cup-shaped disc, capsule not seen. *Mitrasacme cheesemanii*, J. Buchanan, in Trans. N.Z. Inst., xiv. (1881), 348, t. xxix., f. 2.

South Island: Otago—Mount Alta, *J. Buchanan* and *McKay ;* 5,000ft.

A remarkable species, allied to *V. tetrasticha*, Hook. f., but distinguished by its erect wiry branches, smaller leaves, and umbellate flowers. I am indebted to my friend Mr. Buchanan for a small portion of his original specimen, but more copious material both of this and of *V. uniflora* must be obtained before a satisfactory diagnosis can be drawn. The leaves of this plant are more minute than those of any other New Zealand species.

**V. uniflora.**

A rigid much-branched plant, 2in.–4in. high, with numerous short tetragonous branches ½in.–1½in. long, about ⅛in. diameter. Leaves densely imbricating, 4-farious, connate at the base, ovate, concave, ciliate near the base. Flowers solitary, terminal. Calyx deeply divided, lobes 5. Stamens 2, filaments very short, included. Ovary villous above. Capsule not seen. *Logania armstrongii*, J. Buchanan, in Trans. N.Z. Inst., xiv. (1881), 347, t. xxviii., f. 3.

South Island: Otago—Hector's Col, Mount Aspiring, *Buchanan* and *McKay !* 5,000ft.

My knowledge of this curious little plant is confined to Mr. Buchanan's original specimen, which he kindly allowed me to examine. It is allied to *V. teatrasticha*, Hook. f., and *V. lycopodioides*, Hook. f., but differs from both in the solitary terminal flowers and the 5-lobed corolla.

*V. lycopodioides*, Hook. f., Handbk., 211.

An erect much-branched spreading shrub, 1ft.–2½ft. high. Leaves of young state filiform, simple or pectinate, or ovate or oblong, lobed or pinnatifid.

South Island: Alpine districts in Marlborough, Nelson, Westland, Canterbury, and Otago; 2,500ft.–5,000ft.

*V. tetragona*, Hook, Ic. Pl., t. 580.

Procumbent or erect, 6in.–30in. high. Leaves in the young state linear-subulate with a broad base, entire, obtuse, laxly imbricating. Sepals and bracts furrowed longitudinally. Capsule broadly oblong, exceeding the sepals, subacute, slightly compressed.

North Island: In mountain districts, Hikurangi, East Cape, Kaimanawa Range, Ruahine Range, Tongariro, Ngauruhoe, Ruapehu, &c., Tararua Range to Mitre Peak and Mount Holdsworth, in great abundance. South Island:

Queen Charlotte Sound, *Dieffenbach*; Gordon's Nob, *Monro*; Wai-au-ua Valley, *Travers*; but not recently observed in either of these localities. Otago — Greenstone Valley, *J. Buchanan!* 2,000ft.–4,000ft.

The only species belonging to the dimorphic section found in the North Island. Flowerless specimens are easily referred to *Dacrydium*.

*V. buchanani*, Hook. f., Handbk., 211.

Stems 4in.–8in. high, robust, much branched, spreading. Leaves decussate, imbricating, spreading or rarely deflexed, excessively coriaceous, glabrous, sessile, suborbicular or orbicular ovate, concave, usually rounded at the tip, ⅛in.–¼in. long and almost as broad. Flowers in 2–4 very short broad obtuse capitula or spikes, peduncles naked below, 10–15-flowered; rhachis pubescent, bracteoles equalling or exceeding the sepals. Calyx tubular divided nearly to the base, lobes ovate-oblong, obtuse, cilate; corolla-tube ventricose, equalling the rounded spreading segments; stamens not exserted; style villous at the base. Capsule twice as long as the sepals, narrowed at both ends, hairy, compressed.

South Island: Otago—Lake District, *J. Buchanan!* Mount Kyeburn, Otemata River, Mount Arnold, *D. Petrie!* 3,000ft.–4,000ft.

It is scarcely possible to add anything to Sir Joseph Hooker's excellent description except with regard to the capsule. Mr. Petrie's specimens are more robust than the original specimens given me by Mr. Buchanan, and at first sight seem different, but it is impossible to separate them. This species is closely allied to *V. carnosula*, Hook. f., of which it may ultimately prove to be a variety.

*V. buxifolia*, Benth., in DC. Prodr., x., 462.

Erect, 1ft.–3ft. high, sparingly branched, branches strict and rather stout. Leaves broadly oblong-obovate, keeled, coriaceous, abruptly truncate or cordate at base, narrowed into a short broad petiole, closely imbricate (in the typical form), often polished, minutely dotted beneath. Flowers in short spikes, ½in.–1in. long or more, in the axils of the upper leaves. Bracts equalling the minutely punctulate calyx; calyx-lobes broadly oblong, obtuse, equalling the corolla-tube; limb of the corolla equalling the tube, spreading, upper segment broadly rounded, the lower narrow subacute. Capsule suborbicular or broadly oblong, compressed, obtuse.

North Island: Ruahine Range, Tongariro, and Ruapehu. South Island: In mountain localities from Nelson to Southland. 1,800ft.–4,000ft.

The leaves below, with the bracts and sepals, are usually,

but not invariably, covered with minute white dots beneath, and the thickened articulations of the stem are unusually prominent in all the forms of this species, some of which are not easily distinguished from *V. lævis*.

Var. *odora*, Hook. f., sp., Fl. Antarct., 62, t. 41.

Erect, 1ft.–8ft. high, usually much branched, branches strict or flexuous. Leaves as in the typical form, but patent. Flowers as in the type, but often larger. The capsule sometimes shows a tendency to become obovate.

South Island: Mountain districts from Nelson to Southland, attaining its greatest luxuriance on the banks of streams in alpine forests. Stewart Island; Auckland and Campbell Islands. Sea-level to 3,000ft.

The spikes are often so numerous as to present a paniculate appearance, and the bracts scarcely differ from the leaves.

**V. gibbsi**, n. s.

A sparingly-branched shrub, 6in.–12in. high; branches as thick as a goose-quill. Leaves decussate, sessile, ⅜in.–⅝in. long, ¼in.–½in. broad, ovate acute or obtuse, coriaceous, imbricating, patent or deflexed, margins strongly ciliated. Racemes 2–4, naked below, shortly exceeding the leaves, broad, obtuse. Rhachis and pedicels very short or 0, pubescent, bracts fully equalling the corolla-tube, ciliated. Calyx campanulate, deeply cleft, lobes lanceolate, acute, ciliate, much shorter than the bracts; corolla-tube tubular, narrow, limb spreading, lobes narrow acute. Stamens shortly exserted, anthers oblong. Capsule ovate, acute, narrowed at both ends, compressed.

South Island: Nelson—Mount Rintoul and Ben Nevis; 3,000ft.–4,000ft.; *F. G. Gibbs!*

This species is nearly related to *V. lævis* and *V. carnosula*, but is distinguished from both by its acute sepals. The ciliate leaves are always glabrous on both surfaces, and often glaucous or purple. I take this opportunity of acknowledging my indebtedness to Mr. Gibbs for his valued assistance in botanical matters.

*V. lævis*, Benth., in DC. Prodr., x., 461.

Calyx-lobes ovate, obtuse or often subacute. Capsule broadly oblong, narrowed at both ends, compressed.

North Island: Ruahine Range, Tongariro, Ngauruhoe, Ruapehu, Tararua Range. South Island: Subalpine and alpine districts from Nelson to Southland. 2,000ft.–4,500ft.

**V. hillii**, n. s.

A small glabrous erect or spreading shrub, 6in.–12in. high; branchlets naked below. Leaves rather crowded, 1in.–1¼in.

long, narrow oblong or lanceolate, sessile or narrowed into a short broad petiole, acute or subacute, usually entire, glaucous beneath. Flowers in axillary racemes or panicles, exceeding the upper leaves. Rhachis puberulous, bracteoles exceeding the short pedicels. Calyx divided nearly to the base, segments oblong-lanceolate equalling the corolla-tube; corolla-tube equalling the lobes, lobes patent or reflexed, rather narrow, rounded, the uppermost narrower and longer than the others. Stamens on very short filaments, scarcely exceeding the corolla-tube. Capsule ovate-lanceolate, narrowed at both ends, compressed.

North Island: Hawke's Bay—Kuripapanga; between the Rangitikei Ford and Erewhon; *A. Hamilton! H. Hill! D. Petrie!* Ruahine Mountains, W. Colenso, in Herb. Kew. South Island: Otago, *J. Buchanan!*

Allied to *V. colensoi*, with which it has hitherto been confused. I am indebted to the director of the Royal Gardens, Kew, for comparing my specimens with Colenso's Ruahine plant. Mr. Hill sends cultivated specimens of what he considers to be the same plant, but the branchlets are clothed with leaves below, the leaves are serrate at the margins, oblong, less acute, while the rhachis is glabrous and the flowers are almost sessile. To what extent these changes have been produced by cultivation it is impossible to say at present.

*V. diosmæfolia*, R. Cunn., in Bot. Mag., sub-t. 3461.

Leaves entire, ¼in.–⅝in. long, elliptical oblong, rigidly coriaceous, keeled below. Sepals 4, obtuse (in all the specimens examined by me). Capsule oblong-lanceolate, narrowed at both ends.

North Island: Auckland—From the North Cape to Hokianga and Whangarei.

Var. *trisepala*, sp., Colenso, in Trans. N.Z. Inst., xv. (1882), 324.

Branchlets very slender. Leaves ½in.–1in., narrow, linear-oblong, with 3 or 4 incisions on each side, narrowed at both ends, falcate, spreading, not keeled. Calyx-lobes 3, broadly obtuse, the upper emarginate or obcordate. Capsule elliptic-ovate, narrowed at both ends.

North Island: Auckland—Bay of Islands and Hokianga; Hawke's Bay—North end of Te Kaweka Range;* *A. Hamilton!*

The obcordate or emarginate upper sepal pointed out by Mr. Colenso as characteristic of this form is invariably present in all the specimens examined by me, and is occasionally met

* First mentioned, but not described, in Trans. N.Z. Inst., iii. (1870), 169.

with in the type. White or purple flowers are produced on both forms, but I have not seen acute sepals on either. The extension of this species to Te Kaweka is of great interest, and quite unexpected.

*V. elliptica*, Forst., Prodr., n. 10.

This species varies in the colour of the flowers, which in the southern form are pure white, in the northern form white with fine purple lines on the upper petals. The former is rare on the northern side of Foveaux Strait, but is the only form on the Snares and the Auckland and Campbell Islands. The latter occurs on both coasts of the South Island, from west Wanganui, Nelson, and eastern Otago to Stewart Island. It is said to have been found on Banks Peninsula, but the statement requires confirmation.

Chatham Islands: *Captain Gilbert Mair!*

*V. vernicosa*, Hook. f., Handbk., 208.

The leaves of this pretty little species are sometimes distichous, and the racemes very lax, although usually the flowers are densely crowded. *V. canterburiensis*, J. B. Armstrong, in Trans. N.Z. Inst., xiii. (1880), is identical with this on the authority of Mr. N. E. Brown, of Kew; but it must be remarked that until of late years *V. vernicosa* has not been understood by New Zealand botanists, *V. odora*, Hook. f. (Fl. Antarct., i., 62, t. 41), having been mistaken for it, an error in which the authorities at Kew appear to have participated for a time. An Otago specimen of *V. odora* given me by Mr. Buchanan in 1868 was labelled *V. vernicosa*. My own specimens, n. 633, sent to Kew in 1877, were referred to the same species, and in the colony the name was applied to plants of *V. odora* cultivated in the fine collection in the Public Domain, Christchurch. The error was pointed out by Mr. N. E. Brown in 1892.

*V. parviflora*, Vahl, Symb. Bot., iii., 4; Bot. Mag., t. 5965.

Racemes equalling or exceeding the leaves, obtuse or tapering, pedicels shorter or longer than the flowers, puberulous. Calyx deeply divided, lobes obtuse, puberulous or ciliated; corolla-tube broad, limb unequal, spreading, upper lobe solitary and with the lateral lower lobes broadly rounded, middle lobe linear. Capsule twice as long as the calyx, ovate, subacute.

A much-branched shrub, sometimes 18ft. in height, with a trunk nearly 1ft. in diameter at the base.

North and South Islands: From the Great Barrier Islands southwards, but sometimes absent from large districts, as the Auckland Isthmus, the Thames Goldfield, &c.

Var. *arborea*, sp., J. Buchanan, in Trans. N.Z. Inst., vi. (1873), 242.

Similar to the type, but often larger. Sepals broader, ciliated; corolla-tube shorter and broader, limb less spreading, lobes shorter and broader. Capsule ovate-acute, thrice as long as the calyx.

This form attains very large dimensions on the crests of the hills between Kaiwara and Cape Terawhiti (Wellington). One specimen, with the lower part of the trunk almost prostrate, measured 28ft. from the base to the top of the highest branch; the trunk being nearly 2ft. in diameter at the base, but tapering rapidly. Lowland specimens vary from 2ft. to 10ft. in height, and usually form a compact dome-shaped head.

(?) Var. **strictissima.**

Leaves all patent, acute. Racemes 3–6 in the axils of the upper leaves, 3in.–4in. long, strict, erect, tapering; pedicels slender, exceeding the flowers, ascending. Calyx-lobes broadly oblong, rounded at the tips, ciliated. Corolla-tube exceeding the calyx, funnel-shaped, limb spreading, lobes rounded. Capsule not seen.

South Island: Akaroa, 1876, *T. Kirk.*

(?) Var. **obtusa.**

Leaves about 1½in. long, acute, patent. Racemes shorter than the leaves, broad, obtuse, patent; rhachis and pedicels slender puberulous, the latter equalling or exceeding the calyx, patent. Corolla-tube broad, fully twice as long as the calyx, lobes rounded, spreading; stamens much exserted. Capsules not seen.

North Island: Hawke's Bay, *A. Hamilton!*

I have only a single specimen of this plant, which will probably prove a distinct species.

*V. ligustrifolia*, A. Cunn., Bot. Mag., t. 3461.

Calyx divided nearly to the base, sepals lanceolate, acuminate, pubescent; corolla-tube shorter than the calyx, funnel-shaped, limb longer than the tube, lobes spreading, acute.

This seems a remarkably local species. Although stated to occur from the Kermadec Islands to Stewart Island, it appears to be absent from very large districts, and is rarely found in abundance.

(?) Var. **gracillima.**

Leaves spreading, 1in.–1½in. long, ⅛in. broad, linear lanceolate, acute, petioles very short or 0. Racemes 2–6 in the axils of the upper leaves, 4in.–5in. long, very slender, flowers

often fascicled, pedicels equalling the flowers or longer. Calyx nearly equalling the corolla-tube, sepals oblong, obtuse or subacute; corolla broadly funnel-shaped, tube equalling the limb, lobes spreading, unequal, upper broadly rounded, lower middle lobe linear subacute. Capsule not seen.

South Island: Westport, *Dr. Gaze!*

This has perhaps equal claim to be placed under the preceding species, but is referred here chiefly on account of the subacute sepals. It will probably prove a valid species.

**V. squalida**, n. s.

Erect, much branched from the base, 3ft.–5ft. high, twigs slender, naked below, flexuous. Leaves 1½in.–3in. long, ¼in. broad, narrow linear-lanceolate, acute, often falcate, usually drooping, concave above. Racemes 2in.–3in. long, ⅓in. diameter, lax, slender, tapering. Calyx deeply divided, lobes broad, obtuse or subacute, ¼–⅓ as long as the narrow corolla-tube, limb of corolla spreading, lobes short, rounded. Capsule (after dehiscence) orbicular-ovate, acute.

South Island: Nelson — Matori, *T. K.*, 1877; Wairoa Valley, *W. H. Bryant* and *T. Kirk*.

This species is distinguished from all others with linear-lanceolate leaves by the long and narrow tubular corolla with small spreading segments, as well as by its naked branches, drooping leaves, and inelegant appearance. The only capsules obtained were too far advanced to allow of a good description being drawn.

*V. chathamica*, J. Buchanan, in Trans. N.Z. Inst., vii. (1874), 339, t. 13, f. 1.

A much-branched prostrate shrub; stems 6in.–18in. long, branches very numerous, wiry, glabrous, or rarely the branchlets and peduncles sparingly pubescent. Leaves close-set, sessile or very shortly petiolate, about ½in. long, elliptical subacute, subcoriaceous flat. Racemes 2–4 in the axils of the uppermost leaves, ½in.–¾in. long and nearly as broad, obtuse peduncles ¼in.–¾in. long. Flowers densely crowded; bracteoles as long as the pedicels. Calyx deeply divided, lobes lanceolate, acute, ciliolate; corolla-tube ventricose, nearly equalling the limb, broad; lobes reflexed, broad, nearly equal, the uppermost larger and more rounded; stamens exserted, shorter than the style. Capsule broadly lanceolate, compressed.

Chatham Islands: *H. H. Travers! F. A. D. Cox!* and others.

Easily distinguished from all other species of this section by the prostrate habit and wiry branchlets, short broad racemes, and the compressed capsule narrowed at both ends.

I have ventured to give an amended description, as Mr. Buchanan confused this plant with the next.

**V. coxiana,** n. s.

Scarcely suffruticose, decumbent, stems 6in.–12in. high or more, soft. Stems, leaves on both surfaces; peduncles, bracteoles, and pedicels clothed with short soft pubescence. Leaves rather distant, sessile or shortly petiolate, 1in. long, elliptical, rounded at the apex, rarely narrowed below, membranous, soft. Racemes as in *V. chathamica* but broader, pedicels longer, bracteoles usually exceeding the pedicels. Sepals lanceolate-acute, pubescent. Corolla-tube exceeding the limb; lobes reflexed, uppermost broader than the others; style shortly exceeding the exserted stamens. Capsule not seen.

Chatham Islands: *H. H. Travers! F. A. D. Cox!*

Distinguished at sight from *V. chathamica* by the stouter suberect stems, pubescent membranous leaves, broader racemes, and by the corolla-tube being longer than the limb. It is the most herbaceous member of the section, being even less suffruticose than *V. cataractæ*, Forst.; usually the only portion of the stem that is at all woody is the short prostrate base. Specimens have been distributed under the name of *V. chathamica*, var. *major*.

I gladly take this opportunity of acknowledging my indebtedness to my friend Mr. Cox for specimens of the plants of the Chatham Islands, accompanied in many cases by valuable information as to their habits and distribution: so that it affords me great pleasure to attach his name to this interesting plant.

*V. macrocarpa*, Vahl., Symb. Bot., iii., 4.

Erect, 4ft.–7ft. high, branchlets rather stout. Leaves 3in.–4in. long, narrow-oblong-lanceolate, acute, rather coriaceous. Racemes usually exceeding the leaves, 4in.–7in. long, cylindrical, acute; sepals oblong, obtuse; corolla very large, white; stamens much exserted.

North Island: Apparently local—Bay of Islands, Waitemata, Tokatea Peaks, Mercury Bay, Tologa Bay. South Island: Marlborough — Cook Strait; Totaranui; Otago. Stewart Island. Sea-level to 2,000ft.

This species is much less frequent than might be expected from the wide area over which it is distributed. I have not seen it growing south of the East Cape, and suspect that the Stewart Island specimens, which are said to have leaves 1in. long, and short broad racemes 1in.–2in. long, belong to some other species.

**V. latisepala**, n. s.

Shrubby, 3ft.–5ft. high, erect, glabrous, branches stout, thick, naked below in old plants. Leaves patent, sessile, sub-coriaceous, 2in.–4in. long, about ½in. wide, linear-lanceolate, acute. Racemes 2–6, axillary near the tips of the branches 1in.–2½in. long, obtuse, 1in. broad, spreading or patent; rhachis, pedicels, bracteoles, and sepals puberulous, bracteoles much shorter than the pedicels, obtuse or subacute. Flowers secund, pedicels exceeding the calyx. Calyx cleft for one-third of its length; segments very short, broadly rounded above, ciliolate; corolla ⅓in.–⅛in. in diameter, tubular, segments but slightly expanded, short, rounded, the uppermost narrower and longer than the others. Stamens exserted, exceeding the style. Capsule broadly ovate, acute, pedicels curved upwards in fruit.

North Island: Great Barrier Island, *T. Kirk;* Whangarei Harbour, T. B. Gillies and T. Kirk.

The nearest affinity of this fine plant is with *V. macrocarpa*, Vahl., from which it differs in the more fleshy narrower leaves, obtuse racemes which are always shorter than the leaves, and especially in the broadly rounded sepals. The flowers are purple, but never approach the deep-violet hue of *V. rotundata*.

**V. rotundata**, n. s.

A laxly-branched shrub, 2ft.–6ft. high, glabrous. Leaves about 3in. long, ¾in.–1in. broad, sessile or abruptly narrowed into a very short sheathing petiole, elliptic-oblong, subacute. Racemes 2–4 in the axils of the upper leaves, 3in.–5in. long, 1in. diameter. Flowers densely crowded, large, rhachis puberulous or pubescent. Calyx divided almost to the base, sepals oblong, subacute or acute; corolla-tube rather shorter than the spreading unequal limb, upper segment narrow, lower segments overlapping; stamens greatly exserted, exceeding the minute capitate stigma. Capsule suborbicular, compressed, broadly rounded at the apex.

North Island: Near Wellington. South Island: Near Southbridge. *T. Kirk.* Probably not infrequent.

This handsome species is distinguished from all others of this section by the broadly-rounded capsules. It has hitherto been confused with *V. salicifolia* and *V. macrocarpa*, from both of which it may be distinguished at sight by the less acute and broader leaves. The flowers are usually of a deep-violet colour when first expanded, but often change to a pale lilac. I was disposed to consider it identical with *V. myrtifolia*, Banks and Sol., but Mr. James Brittain, of the British Museum, South Kensington, who kindly compared it with the original Banksian specimen at my request, assures me that it is distinct.

*V. macroura*, Hook. f., *ex* Benth., in DC. Prodr., x., 459.

In old specimens the branchlets and racemes are more or less pendulous, and the pedicels of the densely-crowded capsules curved upwards.

This littoral species has not been observed either at Whangarei or on the shores of Cook Strait of late years. It is, however, plentiful on many parts of the East Coast from Hicks Bay to the Mahia Peninsula. The Tarndale locality (Nelson), recorded in the Handbook on the strength of specimens found amongst Tarndale plants in Sinclair's herbarium, is certainly erroneous, as this species is only found in the vicinity of the sea. *V. cookiana*, Colenso, in Trans. N.Z. Inst., xx. (1887), 201, from Table Cape, seems to me a variety with broader more or less pubescent leaves and longer racemes. *V. macroura* was originally discovered by the Rev. W. Colenso at Whangarei, the East Cape, and Cook Strait.

*V. dieffenbachii*, Benth., in DC. Prodr., x., 459.

The rather stout branches of this plant are given off in a divaricating manner, so that a single specimen may cover an area many yards in diameter. The stem and leaves are sometimes pubescent.

*V. speciosa*, R. Cunn., in Bot. Mag., sub-t. 3461.

I am informed that this fine plant has been destroyed in its old habitat at the south head of Hokianga Harbour, but believe that it still exists a few miles further south. On the authority of the late Dr. Lyall it is stated to have been found near Port Nicholson, but no other botanist has seen it in this locality. Mr. J. Rutland assures me that it is still to be found on maritime rocks in Titirangi Bay, Marlborough, where it is often drenched with sea-spray.

## Art. LIII.—*New Zealand Musci: Notes on a New Genus.*

By Robert Brown.

*[Read before the Philosophical Institute of Canterbury, 3rd July, 1895.]*

For a considerable number of years I have been practically interested in the New Zealand Musci, and have travelled over a large portion of New Zealand, and been successful in discovering a great number of different species of mosses at present unknown to science. I am now busily occupied in

describing and naming these new mosses, and classifying them in their proper genera. While doing this I have come across a certain moss, collected by me in the upper waters of the River Conway, near Palmer's Pass, Marlborough, which is the subject of this paper. It was growing in patches together with *Dicranum tasmanicum* and several other mosses. At first sight the capsules of this moss bore a striking resemblance to those of *D. tasmanicum*, but on closer inspection I found that it differed in almost every particular from that moss.

The new species is a small pale-green moss, growing in dense patches, and is usually incrusted with a considerable quantity of calcareous matter, owing to the constant percolation of the water through it. The capsule is ovate, with a small mouth; but the interesting point about this moss is its peristome, which has four triangular irregularly-perforated teeth, the perforations being covered by an extremely thin transparent membrane, which is readily seen on staining the peristome.

In the literature available here I have been unable to find any genus in which this plant can be suitably placed; it is therefore proposed that a new one should be created to properly locate it. I have named the new genus *Tetracocinodon*, in reference to its peristome, and this particular plant *T. hectori*, after Sir James Hector.

TETRACOCINODON, gen. nov.

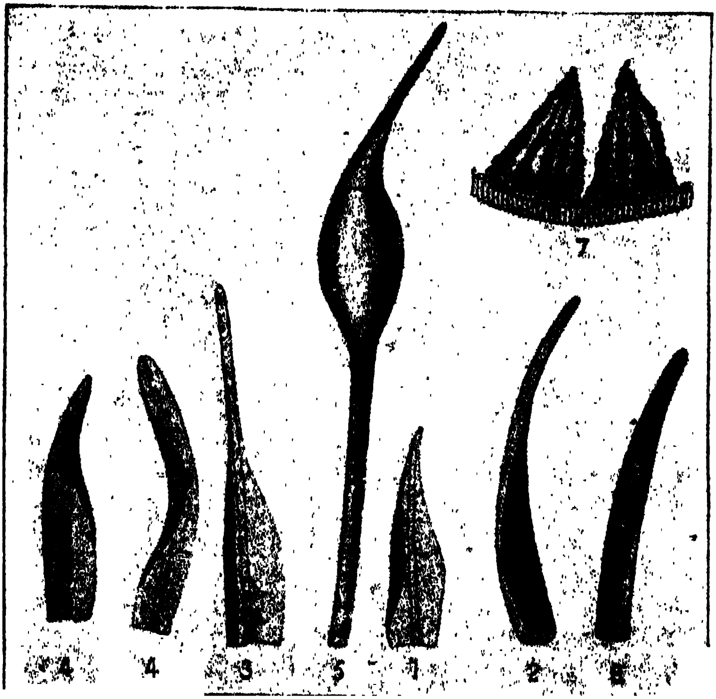
*Capsule* ovate. *Operculum* conico-rostrate, oblique. *Peristome* single. *Teeth* four, triangular, perforated, with or without a thin transparent membrane over the perforation. *Calyptra* cucullate.

**Tetracocinodon hectori**, sp. nov.

*Plants* small, pale-green, growing in patches, from ¼in. to ½in. high. *Stems* nearly simple. *Branches* short. *Leaves* small, inserted all round the stem, erecto-patent, linear, acute or obtuse, slightly concave. *Margins* entire. *Nerve* continuous. *Areola—upper* small, subrotund; *lower* oblong, crisped when dry after the lime is washed out, otherwise scarcely altered. *Perichætial* leaves small, erect; *innermost* smallest, ovate-acute; *outer* one oblong, tapering into a long, subulate point about half the length of the leaf, nerved, concave. *Margins* and *back* minutely papillose. *Fruitstalk* ½in. high, slightly flexuous, sometimes spirally twisted. *Capsule* ovate. *Mouth* small. *Operculum* narrow, oblique, conico-rostrate, longer than the capsule. *Peristome* single. *Teeth* four, triangular, irregularly perforated from immediately below

the apex to near the base, dividing it into from four to five divisions which remain united at the tip; the divisions also being minutely perforated, the perforations having an extremely thin transparent membrane over them. *Calyptra* very narrow, cucullate.

*Hab.* Limestone rocks, head-waters of River Conway; February, 1894. Collected by R. B.




1. Inner perichætial leaf. 2. Outer perichætial leaf. 3. Leaf outside perichætial leaf. 4. Stem-leaves. 5. Capsule. 6. Calyptra. 7. Peristome.

## Art. LIV.—*On some Additions to the New Zealand Flora.*

By T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 7th October, 1895.*]

**Colobanthus squarrosus**, n. sp.

Small, densely tufted, much branched, forming rounded cushions 3in.–4in. in diameter and 2in. high, occasionally more laxly branched and open. Leaves $\frac{1}{8}$in.–$\frac{1}{4}$in. long, rigid or chaffy, spreading, base broad and sheathing, upper part subulate, gradually narrowed to an acute or shortly acicular tip, deeply channelled above, rounded below. Flowers usually terminating the branches, $\frac{1}{8}$in. in diameter, peduncles slightly exceeding the upper leaves. Sepals 5, broadly ovate, acute, margins thin and almost translucent. Stamens 5, much longer than the sepals; hypogynous disc reduced to a mere line. Ovary globose, styles 5. Mature capsules rather shorter than the calyx.

*Hab.* Mount Owen, Nelson, on limestone rocks; alt., 4,000ft.

This differs in a marked degree from *C. acicularis*, Hook. f., and *C. benthamianus*, Fenzl. (*C. subulatus*, Hook. f.), in the shape of the leaves and sepals. The leaves have not the long acicular points of the first species, and the sepals are very different in shape from those of either, being broadly ovate and acute.

**Epilobium rostratum**, n. sp.

A small rigid wiry species, 2in.–5in. high, grey with short fine pubescence. Root hard and woody. Stems few or many, erect, arcuate at the base or spreading, simple or branched, rigid, terete, leafy, hoary with a uniform pubescence of short white hairs. Leaves small, rigid, coriaceous, $\frac{1}{8}$in.–$\frac{3}{8}$in. long, $\frac{1}{12}$in.–$\frac{1}{8}$in. wide, narrow-oblong, obtuse, or more usually terminating in a cartilaginous mucro, lower and intermediate opposite, uppermost often alternate, sessile or very shortly petiolate, margins with 2–3 large and coarse teeth, surfaces wrinkled and corrugated when dry, midrib prominent in the lower two-thirds of the leaf, secondary veins not conspicuous. Flowers very small, crowded in the axils of the upper leaves, $\frac{1}{10}$in.–$\frac{1}{8}$in. long, erect; petals hardly longer than the pubescent calyx lobes. Capsules large, usually about $\frac{1}{2}$in. long, crowded at the ends of the branches, sessile or on very short pedicels,

curved, narrowed upwards into a beak, hoary-pubescent. Seeds obovoid, testa minutely papillose.

*Hab.* Mountain districts in Canterbury and Otago; apparently not uncommon. Upper Waimakariri, and shingly beds of streams near Lake Tekapo and Lake Pukaki, *T. F. C.*; near Naseby, Otago, *D. Petrie!*

A curious and distinct little species, whose nearest allies are *E. melanocaulon*, Hook. f., and *E. erubescens*, Haussknecht. From these it is distinguished by its smaller size, different habit, more coarsely toothed leaves, by the conspicuous uniform pubescence of the stem and branches, and especially by the short, curved, sessile capsules, which are narrowed at the tip so as to appear rostrate, thus presenting a very different appearance from those of any other New Zealand species.

**Epilobium vernicosum**, n. sp.

Rootstock stout, perennial, covered with the remains of the old branches and leaves. Branches numerous, stout, somewhat rigid, decumbent or almost prostrate at the base, erect at the tips, 4in.–6in. high, glabrous with the exception of two lines of pubescence from the bases of the leaves, terete, reddish or green. Leaves usually reddish, opposite except towards the tips of the branches where they are alternate, crowded, very glossy when fresh, coriaceous, usually oblong but varying from linear- or lanceolate-oblong to elliptical or ovate, ¼in.–½in. long, narrowed into very short petioles or almost sessile, obtuse or subacute, lower faintly toothed or nearly entire, upper sinuate-toothed, midrib evident. Flowers very large, ½in.–¾in. long, pale-rose, crowded in the axils of the upper leaves, erect. Calyx lobes linear-lanceolate, acute, much shorter than the broad bilobed petals. Style slender, stigma long, clavate. Immature capsules quite glabrous, nearly sessile.

*Hab.* Mountains of Nelson. Abundant on the Mount Arthur plateau, 3,000ft.–4,000ft. alt., and ascending to over 5,000ft. on Mount Arthur and Mount Peel.

The shining leaves and large rose-coloured flowers, which are produced in great abundance, make this a very charming plant. The flowers are quite as large as those of *E. chionanthum*, Hausskn., and *E. gunnianum*, Hausskn. Its nearest relative appears to be *E. brevipes*, Hook. f., from which it differs in not being so robust or so woody at the base, in the smaller broader leaves on much shorter petioles, and particularly in the much larger flowers. Excellent figures of *E. brevipes* are given in Barbey's Illustrations of *Epilobium* (t. 19) and in Haussknecht's elaborate monograph of the genus (t. 21, f. 89). Both these plates, which are based on

the type-specimens preserved at Kew, show the flowers to be less than half the size of those of *E. vernicosum*, with the lobes of the calyx quite as long as the petals. In *E. vernicosum* the petals exceed the calyx by at least a third of their length.

**Senecio glaucophylla**, n. sp.

Smooth and glaucous, perfectly glabrous, 1ft.–3ft. high. Rootstock stout, woody, perennial. Branches very numerous, closely packed, forming a dense mass of glaucous foliage, usually bare at the very base or furnished with minute scale-like leaves only, strongly grooved and striate, simple or sparingly branched, very leafy above. Leaves 2in.–4in. long, ½in.–1in. wide, oblanceolate, oblong-obovate or obovate-spathulate, obtuse or subacute, irregularly sinuate-dentate or serrate, especially in the upper half of the leaf, gradually narrowed into broad flat petioles, not sheathing nor dilated at the base, very glaucous, texture rather thin, veins conspicuous, reticulate, margins somewhat thickened. Upper stem-leaves narrower, lanceolate or linear-lanceolate, sharply serrate, gradually passing into the bracts, which are narrow, linear, and entire. Flower-heads not very large, several in a loose terminal corymb. Involucre broadly campanulate, scales linear, acuminate, glabrous with the exception of a tuft of woolly hairs at the tip, 2-ribbed. Florets of the ray about 15, in one series; disc-florets numerous. Ripe achenes not seen.

*Hab.* Mount Arthur, Nelson, on limestone rocks; alt., 4,000ft.

A very curious plant, its dense habit of growth and glaucous leaves giving it a very different appearance from any of its allies. The stems seem to die down to the root in winter, a fresh crop appearing in the following spring. My specimens are somewhat immature, and the above description may consequently require modification when more perfect examples have been obtained.

**Senecio adamsii**, Cheeseman. (*S. pachyphyllus*, Cheeseman, Trans. N.Z. Inst., xvi., 410).

I find that the name of *pachyphyllus* is preoccupied by a Chilian plant (Remy in C. Gay, Fl. Chili, iv., 147). I therefore propose the name of *S. adamsii*, in honour of my friend Mr. James Adams, B.A., who was my companion when the plant was originally discovered.

**Gentiana filipes**, n. sp.

Small, annual, perfectly glabrous, 1in.–3in. high. Stems simple or branched, erect, very slender, sparingly leafy. Leaves almost all cauline, few, small, oblong- or obovate-spathulate, lower narrowed into short petioles, upper sessile,

⅛in.–⅙in. long. Flowers solitary, terminating the branches, large for the size of the plant, ⅙in. in diameter, white. Calyx lobes broadly ovate, acute. Corolla divided rather more than one-third way down, lobes subacute.

*Hab.* Mount Arthur, Nelson; alt., 4,000ft.

A curious and pretty little plant, differing from the forms of *G. montana*, Forst., known to me in the calyx lobes, which are broadly ovate, while in *G. montana* they are linear or linear-subulate.

## ART. LV.—*Botanical Notes, Nelson District.*

By R. I. KINGSLEY.

[*Read before the Nelson Philosophical Society, 13th January, 1896.*]

THE following brief notes of the past year may be worth recording, since anything which adds to our knowledge is, to a certain extent, a gain.

**Pimelea gnidia.**

This very handsome shrub has hitherto been very imperfectly described, and I was glad to be able to supply Mr. Kirk with a large number of specimens exhibiting a wide range of variation. Last February I found a specimen in Torrent Bay so distinct that Mr. Kirk thought it worthy of varietal honours, and he proposed to name it var. *involucrata*. Last November I found it pretty plentiful in Sandy Bay, but with considerable variation.

It is a pity such a handsome shrub should not be cultivated; that it would be appreciated is certain, since Mrs. Jennings won a first prize at the local Horticultural Show at Motueka about a year ago with a plant from Sandy Bay, or near by.

**Eugenia maire.**

This handsome North Island tree is stated in the Forest Flora only to have been found in the South Island in Queen Charlotte Sound and the Pelorus. I now record it as growing in the bush at Thackwood, near Nelson.

The handsome berries were gathered by me last January.

**Lindsaya viridis.**

A description of this beautiful fern by Mr. Kirk is printed in vol. x. of the Trans. N.Z. Inst., p. 396, and stated to be both rare and local. It is recorded, from specimens in Kew

Herbarium, to have been found in Massacre Bay, Nelson, by Lyall. Until recently the locality was not known. I found it last year in Torrent Bay, where there are some good specimens.

**Hymenophyllum montanum.**

In vol. x., Trans. N.Z. Inst., p. 394, Mr. Kirk describes this fern as a new species. He states it was sent to him from the mountains at the head of Lake Wakatipu.

In February, 1895, my friend Mr. W. H. Bryant and myself found it growing in the granite country on the western side of Blind Bay; but, strangely, at not more than 40ft. or 50ft. above sea-level, and near the shore. I presume, therefore, it cannot be considered as a strictly mountain species.

## Art. LVI.—*Descriptions of Three New Native Plants.*

By D. Petrie, M.A., F.L.S.

[*Read before the Auckland Institute, 7th October, 1895.*]

**Geum pusillum**, sp. nov.

A small depressed herb. Rootstock as stout as a goose's quill, short. Leaves rosulate, few, 1in. long and ¼in. wide, pinnate; leaflets small, rapidly diminishing from the rather large terminal leaflet, sparsely covered above and chiefly at the edges with rather long stiff hairs.

Scapes simple, slender, yellow, finely and closely pubescent, with two or fewer subulate scale-like bracts.

Flowers solitary, terminal, small; petals 5 or 6, white, small, narrow elliptic, obtuse; stamens twice as many as the petals.

Achenes very small, ending abruptly in a short recurved style ⅛ to $\frac{1}{10}$ the length of the achene.

Receptacle elongate, conical, hairy.

*Hab.* Old Man Range, Otago, 5,000ft. A very distinct plant. Its simple short slender scapes, small solitary flowers, and minute short-styled achenes readily mark it off from all the other native species of the genus. A small bibracteate involucel sometimes occurs below the flower, but I cannot say whether this is constantly present.

**Epilobium pictum**, sp. nov.

A slender species, 6in. to 10in. high, generally branched from the base, sometimes with short branches springing from

the axils of all the cauline leaves, decumbent at the base or erect, finely and densely pubescent.

Lower leaves opposite, upper alternate; diminishing but slightly upwards, rather distant, glabrous, membranous, subsessile, sharply narrowed at the base, narrow ovate-elliptic, obtuse, coarsely and sharply toothed (four or five pairs of teeth projecting beyond the general outline of the leaf on either side), ¾in. long, ¼in. wide, above pale-green blotched with grey, more or less red below; midrib evident, translucent, secondary nerves very inconspicuous.

Flowers several (about 6), crowded in the axils of the uppermost leaves, rather small, pink, very shortly pedicelled, pedicels ⅛in. to ⅙in. long. Capsules slender, very pubescent, 1¼in. to 1½in. long; pedicels not lengthening in fruit. Seeds smooth.

*Hab*. Mountain valleys of Central Otago, from 1,500ft. to 3,000ft.; Lowburn Creek; Obelisk Creek; Mount St. Bathan's.

This species is closely related to *E. alsinoides*, Hook. f. It differs in the larger leaves that are not opposite above, the erect stem, the coarser teeth, the pink flowers, and the short pedicels that do not elongate in fruit.

**Myosotis (Exarrhena) oreophila**, sp. nov.

A depressed alpine perennial. Stems few, ascending, 3in. to 4in. long, slender, leafy, hispid and grey with appressed stiff white hairs.

Radical leaves long-petiolate, linear-spathulate, obtuse, rather membranous, rather closely clothed with appressed stiff white hairs, 2in. long or less.

Lower cauline leaves like the radical, but smaller; upper linear-oblong, sessile, acute.

Flowers in a small capitate cyme, ebracteate, sessile or subsessile, 10 to 16 in number. Calyx ¼in. long, cut nearly to the middle into five acute lobes, hispid with stiff appressed or slightly-spreading hairs. Corolla one-half longer than the calyx, funnel-shaped, purple, the lobes 5, spreading, and obtusely rounded.

Stamens 5, very slightly exserted; filaments nearly as long as the pendulous anthers, springing from the base of the corolla lobes; scales obscure.

Style twice as long as the calyx, slender.

Ripe nuts not seen.

*Hab*. Mount Ida, Otago, 4,000ft., on finely-broken shingle. I have had this plant for many years, but have never been able to find it a second time. While it has some affinity to the Dun Mountain *Exarrhena*, its nearest ally seems to be *M. traversii*, Hook. f.

## Art. LVII.—*List of the Flowering Plants indigenous to Otago, with Indications of their Distribution and Range in Altitude.*

By D. Petrie, M.A., F.L.S.

[*Read before the Otago Institute, 8th October, 1895.*]

The following list contains all the species of flowering plants which I have gathered in Otago and Stewart Island in the course of the last twenty years. In an appendix is given a list of additional plants recorded from the district which I have not myself observed in the field.

My explorations have been mainly confined to the eastern, central, and southern regions, the phanerogamic plants of which may now be said to be fairly well known, except as regards their distribution. The region lying to the west of the Lake District and the south-west corner are still but imperfectly known, and its higher mountains will doubtless yield a good many novelties to the adventurous collector who penetrates into these rather inaccessible wilds. The plants of the lowlands of the east and south are very much the same as are found generally in the lowlands of the eastern division of the South Island. Those of the higher mountains of the centre and north belong, with few exceptions, to the alpine flora that prevails throughout the central and southern regions of the Southern Alps.

The higher plains of the interior bear a small number of species that appear to be peculiar to those districts, but most of them will no doubt be found sooner or later in similar stations in the upper basins of the Canterbury rivers. Of this kind are various species of *Carmichælia*, *Acæna*, *Lepidium*, *Raoulia*, and *Carex*, and of *Poa* and *Triodia* among grasses.

There is thus an unbroken continuity in the phanerogamic flora of the central and southern regions of the South Island, a fact in perfect keeping with their physical relations. The great valley of the Waitaki River hardly makes a greater break in the eastern plateau and in the character of the flora that flourishes on it than does any other of the great Canterbury rivers.

The Clutha Valley, on the other hand, from Lake Wanaka to Roxburgh, forms an important boundary-line, for a good number of the alpine plants found on the west of it do not appear to extend to the mountains lying to the east. The alpine plants, for example, found on the Dunstan Mountains, the St. Bathan's Range, and the Mount Ida and Kurow Ranges, are in large measure different from the corre-

sponding flora on the higher mountains west of the Clutha Valley.

I have not found leisure to enter on any discussion of the questions of distribution which the facts recorded in the present paper suggest. To this I may return at some future opportunity. The only abbreviation used in the list that needs explanation is C., which stands for the *central region* of Otago.

CLEMATIS INDIVISA, Willd.—Common in forests of E. and S.

CLEMATIS FŒTIDA, Raoul.—Not rare on E., but local. Dunedin; Otepopo; Kaitangata.

CLEMATIS COLENSOI (?) Hook. f.—Matukituki Valley.

CLEMATIS MARATA, Armstr.—In scrub of E. and C. Kurow; Tuapeka R.; Hyde.

CLEMATIS AFOLIATA, Buchanan.—Awamoko; Duntroon.

MYOSURUS ARISTATUS, Benth.—Hyde; Beaumont; Speargrass Flat; Ida Valley; Lake Wanaka.

RANUNCULUS LYALLII, Hook. f.—Mountains near Mount Aspiring (3,500ft.-5,000ft.); Clinton Saddle, Te Anau (3,800ft.). Seems confined to mountains near western water-parting.

RANUNCULUS BUCHANANI, Hook. f.—Hector Mountains; Humboldt Mountains (5,000ft. and above).

RANUNCULUS HAASTII, Hook. f.—Mount St. Bathan's and Mount Kyeburn, on loose shingle (4,000ft.-5,500ft.).

RANUNCULUS SERICOPHYLLUS, Hook. f.—Mount Aspiring district (4,500ft.), and mountains west of Hunter River, Lake Hawea (over 5,000ft.).

RANUNCULUS SINCLAIRII, Hook. f.—Maungatua, and mountains of E. side. (I am not sure that this may not rather prove a form of *R. gracilipes*, Hook. f.)

RANUNCULUS PLEBEIUS, R. Br.—Throughout Otago; common in bush and open lands.

RANUNCULUS LAPPACEUS, Sm., var. MULTISCAPUS.—Common throughout in open lands; ascending to 4,000ft.

RANUNCULUS SUBSCAPOSUS (?) Hook. f.—A plant which I take to be a form of this species is not rare in mountain-valleys of C. and W.

RANUNCULUS MACROPUS, Hook. f.—Near Port Molyneux.

RANUNCULUS RIVULARIS, Banks and Sol.—Common in moist and boggy stations up to 2,000ft.

RANUNCULUS ACAULIS, Banks and Sol.—Common on E. coast; Mount St. Bathan's (3,500ft.).

Ranunculus gracilipes, Hook. f.—Mount Ida and Dunstan Ranges (3,000ft.-4,500ft.).

Ranunculus pachyrrhizus, Hook. f.—Old Man Range; Hector Mountains; Mount Pisa; Mount Cardrona; &c. (above 5,000ft.).

Ranunculus ternatifolius, T. Kirk.—Swampy Hill; Port Molyneux; Catlin's district. Seems confined to E. lowlands.

Ranunculus depressus, T. Kirk.—Shores of Lake Te Anau.

Ranunculus depressus, var.—Mount Cardrona (4,500ft.). This may prove a distinct species. The fruit is still unknown.

Ranunculus tenuicaulis, Cheeseman.—Swampy Hill; Lee Stream, sources of; Mount Kyeburn; Clinton Saddle, Te Anau (1,000ft.-3,000ft.).

Ranunculus berggreni, Petrie.—Carrick Range (4,000ft.). Fruit still unknown.

Ranunculus chordorhizos, Hook. f.—Mount Kyeburn and Mount St. Bathan's (4,000ft.). In fine shingle *débris*.

Ranunculus areolatus, Petrie.—Mountains at head of Lake Wakatipu. Collected by Mr. A. C. Purdie.

Ranunculus novæ-zealandiæ, Petrie.—Rock and Pillar and Old Man Ranges (above 4,000ft.). In rough shingly stations. Fruit still unknown.

Ranunculus kirkii, Petrie.—Head of Paterson's Inlet. This is reported from Kew as a very distinct species, unlike any known from the Southern Hemisphere.

Ranunculus limosella, F. von Mueller.—Maniototo Plain; Roxburgh. In shallow lagoons.

Caltha novæ-zealandiæ, Hook. f.—Old Man Range; Dunstan Mountains; and all mountains more to W. (above 4,000ft.).

Drimys colorata, Raoul.—Common in bush throughout.

Nasturtium palustre, DC.—Wet grounds and shallow water-pools throughout, up to 2,000ft.

Sisymbrium novæ-zealandiæ, Hook. f.—Dry stations in mountains of E. and C., up to 2,500ft.

Sisymbrium novæ-zealandiæ, var.—A very small, slender form. Dry stations, Waitaki district; Kurow; Duntroon; Otepopo R.

Cardamine hirsuta, L.—Abundant; has a great range in altitude.

CARDAMINE DEPRESSA, Hook. f.—Kurow Mountains, Mount Ida Range, and Hector Mountains (300ft.–3,000ft.).

CARDAMINE ENYSII, Cheeseman (MS.).—Mount Ida (4,000ft.), on bare, dry, rocky faces.

PACHYCLADON NOVÆ-ZEALANDIÆ, Hook. f.—Rock and Pillar Range, and all high mountains W. of it (above 4,000ft.).

CAPSELLA PROCUMBENS, Fries.—Waikouaiti; Oamaru; Dunedin. On spray-washed cliffs.

LEPIDIUM OLERACEUM, Forst.—E. coast, now rather rare; Oamaru; Port Chalmers; Catlin's.

LEPIDIUM SISYMBRIOIDES, Hook. f.—Kurow, on shingly flats and stony hill-slopes.

LEPIDIUM TENUICAULE, T. Kirk.—Oamaru; Hampden; Awamoko; Weston; Orepuki. Usually near the sea; but the specimens from Weston and Awamoko are the finest and best-grown I have seen. It grows only in salty spots.

LEPIDIUM KAWARAU, Petrie.—Bluff, near Gibbston, Kawarau River, and Duntroon (The Earthquakes). The Duntroon plant may be a distinct species. I have not succeeded in finding Mr. Kirk's *L. australe*, said to grow at the headland at Oamaru.

LEPIDIUM MATAU, Petrie.—Alexandra South, and Gimmerburn district. Confined to salty situations.

LEPIDIUM KIRKII, Petrie.—Gimmerburn; Bannockburn. Confined to salty situations.

NOTOTHLASPI ROSULATUM, Hook. f.—Mount Ida. I record this on the authority of Mr. P. Goyen, F.L.S., who has a sufficient knowledge of plants to recognise this very peculiar form.

VIOLA FILICAULIS, Hook. f.—Common in forests and scrub.

VIOLA CUNNINGHAMII, Hook. f.—Common up to 3,500ft., chiefly in open lands.

VIOLA HYDROCOTYLOIDES, Armstr.—Head of Paterson's Inlet.

MELICYTUS RAMIFLORUS, Forst.—Common in forests of E.

MELICYTUS LANCEOLATUS, Hook. f.—Dunedin; Catlin's; Seaward Bush. Nowhere abundant.

MELICYTUS MICRANTHUS, Hook. f.—Hampden; Waikouaiti; Dunedin; Catlin's. Uncommon in the S.; more abundant in the N.E.

HYMENANTHERA CRASSIFOLIA, Hook. f.—Dunedin; Hampden; Kurow; Clyde; Cromwell; Queenstown.

Hymenanthera angustifolia, R. Br.—Catlin's; Kelso. Rare. This is doubtless Brown's species. I have never seen it in flower. It is almost leafless.

Pittosporum tenuifolium, Banks and Sol.—Common in lowland forests throughout.

Pittosporum eugenioides, A. Cunn.—Common in forests of the E. and S.E.

Gypsophila tubulosa, Boiss.—Many dry localities in N.E. and C. It is uncertain if this plant is truly indigenous; but it does not spread rapidly or occupy the ground closely, as introduced weeds usually do.

Stellaria parviflora, Banks and Sol.—Common in bush throughout.

Stellaria elatinoides, Hook. f.—Tuapeka Mouth; Sowburn; Speargrass Flat. A local plant, but not rare where it occurs.

Stellaria gracilenta, Hook. f.—Common in dry mountain and lowland stations of C. and N., ascending to 4,000ft.

Colobanthus billardieri, Fenzl.—Common in open lands. Stunted forms ascend to 4,000ft. and 5,000ft. in the mountains of the C. and W., on which they form large compact patches.

Colobanthus subulatus, Hook. f.—Kurow; Speargrass Flat; Cromwell; Queenstown; &c. Common in dry, low stations of C.

Colobanthus acicularis, Hook. f.—Kurow and Mount Ida Ranges (2,000ft.-3,000ft.).

Spergularia rubra, Pers.—Tuapeka district, where it spreads rapidly by roadsides, and has every sign of being introduced.

Spergularia rubra, var. marina.—Common on clay cliffs of E. coast.

Claytonia australasica, Hook. f.—Common in moist stations of C., N., and W. up to 5,000ft.; sandhills at Dunedin.

Montia fontana, L.—Common in upland and mountain streams up to 4,500ft.

Hectorella cæspitosa, Hook. f.—Rock and Pillar Range; Old Man Range; and all high mountains west of Clutha River (above 4,000ft.).

Elatine americana, Arnott.—Strath Taieri; Maniototo Plain; Lake Wanaka; Lumsden; Lake Te Anau. On clay- and mud-banks, on edges of lagoons and sluggish streams; Wickliffe Bay, *fide* Mr. B. C. Aston.

HYPERICUM GRAMINEUM, Forst.—Common in lowlands of C., N., and N.E. A very variable plant.

HYPERICUM JAPONICUM, Thunb.—Less common than *H. gramineum*, equally widespread, and reaching a greater altitude, even to 3,000ft.

PLAGIANTHUS BETULINUS, A. Cunn.—Common on alluvial flats on E. and S.

PLAGIANTHUS DIVARICATUS, Forst.—Common on edge of salt lagoons and marshes along E. and S. coasts.

PLAGIANTHUS LYALLII, Hook. f.—Hector Mountains; head valleys of Pomahaka; more plentiful in valleys of western mountains; Matukituki; Hunter River; Clinton River; &c.

HOHERIA ANGUSTIFOLIA, Raoul.—Not rare in lowland forests of E. and S.

ARISTOTELIA RACEMOSA, Hook. f.—Common in bush throughout. When bush is cleared and then neglected this tree grows up in great abundance.

ARISTOTELIA FRUTICOSA, Hook. f.—Swampy Hill; Romahapa; Eweburn Creek; Arrowtown; &c. Common in mountain valleys of C. and W.

ELÆOCARPUS HOOKERIANUS, Raoul.—Not rare in forests of E. and S. up to 2,000ft.

LINUM MONOGYNUM, Forst.—Common in sandy and rocky stations on E. and S. coasts. Rare inland, as at Kurow and Mount Ida Range.

LINUM MARGINALE, A. Cunn.—Rare and local. Dunedin; Miller's Flat; Clyde; St. Bathan's.

GERANIUM DISSECTUM, L., var. CAROLINIANUM.—Not common. Kurow; Awamoko; Ngapara. Not observed in S. and C. districts.

GERANIUM MICROPHYLLUM, Hook. f.—Very common. Ascends to 4,000ft.

GERANIUM SESSILIFLORUM, Cav.—Common. Ascends to 4,000ft.

GERANIUM MOLLE, L.—Eastern region, not rare. In many localities this plant appears to be introduced.

PELARGONIUM AUSTRALE, Willd., var. CLANDESTINUM.—Not rare in open and fern lands.

OXALIS CORNICULATA, L.—Common in dry stations, but most abundant in C. district.

OXALIS MAGELLANICA, Forst.—Not rare in moist stations at 1,000ft. to 3,000ft. Dunedin; Horse Range; Rock and Pillar Range; &c.

MELICOPE SIMPLEX, A. Cunn.—Not rare in forests of E. and S.; less common inland. Beaumont; Clyde; Cambrians. Very often the host of *Viscum lindsayi*, Hook. f.

PENNANTIA CORYMBOSA, Forst.—Forests of E. and S., rather rare; chiefly on rich alluvial or volcanic lands.

STACKHOUSIA MINIMA, Hook. f.—Not rare in C. Naseby; St. Bathan's; Tinkers; Hawea Flat. Reaches 3,000ft. on Mount Ida and Dunstan Ranges.

DISCARIA TOUMATOU, Raoul.—Common in rich open lands and mountain valleys. Grows only in soils of high fertility.

CORIARIA RUSCIFOLIA, L.—Common in forests and valley-slopes of E. and S.; less common in the C. and W. districts.

CORIARIA THYMIFOLIA, Humb.—Common in open grass-lands. Horse Range; Waihemo; Tuapeka; &c.

CORIARIA ANGUSTISSIMA, Hook. f.—Not rare in high mountain valleys of C. and W. Eweburn Creek; Nevis River; Hunter River; Clinton Valley; &c.

CARMICHÆLIA CRASSICAULIS, Hook. f.—Nenthorn; Naseby; and westward to Dunstan Mountains. Local, and confined to the N.C. district.

CARMICHÆLIA MONROI, Hook. f.—Kurow; Mount Ida; Mount St. Bathan's; Carrick and Hector Mountains; and all mountains of Lake District. 200ft.-4,000ft.

CARMICHÆLIA NANA, Colenso.—Waitaki, Maniototo, and Lake Districts. Common on alluvial lowlands; ascends to 2,000ft.

CARMICHÆLIA FLAGELLIFORMIS, Colenso.—Common in open and scrubby lands throughout; ascends to 2,500ft.

CARMICHÆLIA JUNCEA, Colenso.—Lowlands of Waitaki, Maniototo, and Lake Districts; ascends to 2,000ft.

CARMICHÆLIA ENYSII, T. Kirk.—Spurs of Mount Ida Range, at Eweburn Creek; 3,000ft.

CARMICHÆLIA UNIFLORA, T. Kirk and J. Buch.—Head of Lake Hawea, alluvial flats.

CARMICHÆLIA KIRKII, Hook. f.—Rare and local. Otepopo River; valleys in east and west of Rock and Pillar Range; Sowburn.

CARMICHÆLIA COMPACTA, Petrie.—Kawarau and Clutha Gorges, between Arrowtown and Roxburgh.

CARMICHÆLIA PETRIEI, T. Kirk (MS.).—Valleys and terraces on east and west of Dunstan Mountains. Most abundant in Clutha Valley, north of Clyde.

CARMICHÆLIA CORYMBOSA, Colenso, var.—Clinton Valley and head of Lake Te Anau. The flowers are unknown. This plant may prove a distinct species.

CARMICHÆLIA ERECTA, Petrie.—Waitaki Valley, above and below Kurow, chiefly on the river-banks.

CARMICHÆLIA DIFFUSA, Petrie.—Sea-coast north of Otepopo River.

SWAINSONIA NOVÆ-ZEALANDIÆ, Hook. f.—Mount St. Bathan's (4,000ft.-5,000ft.). I found this plant here eighteen years ago, and have never succeeded in finding it again.

SOPHORA TETRAPTERA, Aiton.—Alluvial flats of E. and S., and river-terraces and dry hill-slopes of C. and N. The mountain forms are in several ways different from the lowland ones.

RUBUS AUSTRALIS, Forst.—Common in forests and scrubby valleys throughout. Everywhere exceedingly variable.

POTENTILLA ANSERINA, L.—In wet and swampy stations throughout; ascends to 3,000ft. I think this plant must be considered truly indigenous.

GEUM URBANUM, L., var. STRICTUM.—Not rare by sides of lowland streams up to 2,000ft.

GEUM PARVIFLORUM, Commerson.—Common in mountain valleys of C. and W. (2,000ft.-4,000ft.). Most easterly stations, Kurow and Kakanui Mountains.

GEUM LEIOSPERMUM, Petrie.—Upper Waipori; Cambrians; Mount Cardrona (above 1,500ft.).

GEUM PUSILLUM, Petrie.—Old Man Range (4,000ft.).

ACÆNA SANGUISORBÆ, Vahl.—Common in open lands and edges of bush.

ACÆNA ADSCENDENS, Vahl.—Not rare on the mountains and in the higher mountain-valleys of C. and W. Old Man Range; Hector Mountains; Mount Pisa; Mount Cardrona; &c. (3,000ft.-5,500ft.).

ACÆNA MICROPHYLLA, Hook. f.—Not uncommon in lowlands and lower mountain valleys of C. and S. Rare near Dunedin.

ACÆNA BUCHANANI, Hook. f.—Common in Clutha Valley above Cromwell.

ACÆNA INERMIS, Hook. f.—Not uncommon in dry mountain valleys of N. and C. Naseby; Clyde; Hunter Valley; &c. I do not think this specifically distinct from *A. microphylla*, Hook. f. Complete series of intermediate forms can be gathered in many districts.

Acæna depressa, T. Kirk. — Cardrona Valley; Matukituki Valley. I consider this species a form of *A. microphylla*, Hook. f.

Acæna novæ-zealandiæ, T. Kirk.—Otago Heads; Manuka Creek district. This plant spreads very readily in barren cultivated pastures, as does also *A. sanguisorbæ*, Vahl.

Acæna glabra, Buchanan.—Mount Ida (3,500ft.).

Carpodetus serratus, Forst.—Common in forests of E. and S., more rare in the valleys of the W. Matukituki Valley.

Weinmannia racemosa, Forst.—Dunedin (rare). Abundant in forests south of mouth of Taieri.

Tillæa moschata, DC.—Sparingly on spray-washed cliffs of E. coast.

Tillæa sinclairii, Hook. f.—Waihola; Waikouaiti. More common in the inland plains of the C. and S. in wet stations.

Tillæa verticillaris, DC. — Common throughout; more succulent near the coast.

Tillæa purpurata, Hook. f.—Moist stations near Pembroke. A very local plant, and most easily overlooked.

Tillæa multicaulis, Petrie.—Maniototo and Manuherikia Plains, 1,200ft.–2,800ft.

Tillæa novæ-zealandiæ, Petrie.—Lake Waihola; Waipahi. The plant from Te Anau formerly referred by me to this species is most likely a form of *T. sinclairii*. The Lake Waihola and Waipahi plants may prove distinct when better known.

Drosera stenopetala, Hook. f.—Frazer Peaks, Stewart Island; Longwood Range; Hector Mountains. Not seen on any of the mountains of the E. or N.

Drosera arcturi, Hook.—Common on high mountain-bogs. Maungatua; Blue Mountains; &c.

Drosera spathulata, Labill.—Mouth of Clutha River; Catlin's; lowlands of Southland. Ascends to 3,000ft. on Blue Mountains.

Drosera binata, Labill. — Lowland boggy stations from mouth of Clutha River to Riverton. This seems to be a strictly lowland plant. It occurs at 1,000ft. near Pembroke, the highest station known to me.

Haloragis alata, Jacq. — Not rare in the E. Dunedin; Otepopo; Palmerston. A very uncommon plant inland.

Haloragis tetragyna, Labill, var. diffusa.—Hills about Dunedin and near E. coast at 2,000ft. or less; more com-

mon on mountains of interior and W., there ascending to 3,000ft. or more. This plant is steadily spreading on hill-sides denuded by fire or close cropping by sheep or rabbits.

HALORAGIS DEPRESSA, Hook. f.—Abundant in open and even scrubby lands, and very variable.

HALORAGIS MICRANTHA, Hook. f.—Moist hillsides throughout the district; local, but widespread.

HALORAGIS UNIFLORA, T. Kirk.—Dunedin; Kelso; Maniototo Plain; and plains of Upper Clutha and its affluents. I cannot distinguish this from *H. depressa*, Hook. f. At Signal Hill, near Dunedin, all states between *H. uniflora* and *H. depressa* can be readily found.

HALORAGIS SPICATA, Petrie.—River-flats at head of Lake Hawea. At Kew this is reckoned a distinct species, but a fuller knowledge of intermediate forms may possibly unite it with *H. depressa*. Such intermediate forms are as yet unknown.

MYRIOPHYLLUM ELATINOIDES, Gaudichaud.—Not rare in lagoons and sluggish streams. Lake Waihola; Taieri Plain; Maniototo Plain; &c.

MYRIOPHYLLUM VARIÆFOLIUM, Hook. f.—Not rare in same stations as the foregoing species.

MYRIOPHYLLUM PEDUNCULATUM, Hook. f.—Not uncommon in miry bogs and wet grounds. Taieri Plain; Inch-Clutha; Lumsden; Roxburgh; Maniototo Plain; &c.

GUNNERA MONOICA, Raoul.—Common on wet banks.

GUNNERA OVATA, Petrie.—Kaikorai Swamp; Inch-Clutha; Catlin's; Hindon; and many boggy localities, among *Sphagnum*.

GUNNERA DENTATA, T. Kirk.—Not rare in the silt of river-beds in the mountain valleys of the far W. Matukituki Valley; Hunter River; head of Lake Wakatipu; Lake Te Anau. This is a strictly western species. It seems not to pass E. of the Lake District, and is absent from the middle region of Otago.

CALLITRICHE VERNA, L.—Not rare in slow streams; more common inland than in the E. and N.

LEPTOSPERMUM SCOPARIUM, Forst.—Abundant in scrub on clay hills throughout.

LEPTOSPERMUM ERICOIDES, A. Rich.—As wide-spread as the preceding, but not so plentiful.

METROSIDEROS LUCIDA, Sm.—Common in forests of the S. Northern limit on E. is at Taieri Mouth. A few small trees grow at Lake Wakatipu.

METROSIDEROS HYPERICIFOLIA, A. Cunn.—Common in forests of E., S., and W.

MYRTUS OBCORDATA, Hook. f.—Not rare in forests of E. and S.; sparingly found in the Lake District.

MYRTUS PEDUNCULATA, Hook. f.—Not rare in forests of E. and S. Ascends to 2,500ft.

FUCHSIA EXCORTICATA, L. f.—Common in forests of E. and S. This tree grows up very readily in neglected bush-clearings, where *Aristotelia racemosa*, Hook. f., generally accompanies it.

FUCHSIA COLENSOI, Hook. f.—Not rare on edges of bush and in open valleys inland. Dunedin; Lawrence; Horse Range; Cambrians; &c.

EPILOBIUM CHIONANTHUM, Hausskn.—Not rare in lowland boggy stations. Dunedin; Port Molyneux; Catlin's; Moa Flat; Te Anau; &c.

EPILOBIUM JUNCEUM, Solander.—Common in dry stations throughout the district.

EPILOBIUM PALLIDIFLORUM, Solander.—Common in lowland bogs. Dunedin; Taieri Plain; Kaitangata; Catlin's; Kelso; Lumsden; &c.

EPILOBIUM BILLARDIERIANUM, Seringe (=*E. tetragonum* of the Handbook).—Common in moist lowlands of E. and S. Kakanui; Waikouaiti; Otago Heads; Dunedin; Catlin's; &c.

EPILOBIUM PUBENS, Lesson and Richard.—Common in dry stations throughout, both in bush and in open stations.

EPILOBIUM CONFERTIFOLIUM, Hooker.—Not uncommon on the mountains of C. and W.: Old Man Range (4,000ft.); Hector Mountains; &c. Also in mountain valleys, at 1,200ft. and upwards: Arrowtown; valleys of Mount Ida; and valleys of Lake District.

EPILOBIUM HECTORI, Hausskn.—Apparently not rare in mountain valleys of the C. and W. Mount St. Bathan's; Old Man Range. I do not feel quite certain of my identification of this species.

EPILOBIUM ALSINOIDES, A. Cunn.—Common in lowlands and the lower mountain-slopes throughout. Dunedin; Naseby; Tapanui; head of Lake Wakatipu; &c.

EPILOBIUM ROTUNDIFOLIUM, Forster.—Common in wet stations in bush, and in moist valleys of interior. Dunedin; Catlin's; Cromwell; Arrowtown; Roxburgh; &c.

EPILOBIUM INSULARE, Hausskn.—Not rare in lowland boggy stations. Kaitangata; Catlin's; Heriot; Lumsden; Dunedin.

EPILOBIUM LINNÆOIDES, Hooker.—Rather uncommon; in moist stations in bush. Dunedin; Catlin's; Seaward Bush; Lake Te Anau; &c.

EPILOBIUM NUMMULARIFOLIUM, A Cunn.—Common in the E. and in most parts of the interior up to 3,000ft.

EPILOBIUM PEDUNCULARE, A. Cunn. — Common in same stations as the foregoing, and probably identical with that species.

EPILOBIUM GLABELLUM (?), Forster.—Common on dry, open hills throughout. Tapanui; Cromwell; St. Bathan's; Naseby; &c.

EPILOBIUM ERUBESCENS, Hausskn.—Not rare in mountain valleys of C., N., and W. Mount Ida; Arrow River; Clinton Valley; &c.

EPILOBIUM MELANOCAULON, Hooker.—Common in shingly valleys of C., N., and W. Naseby; Lake District; Te Anau; &c.

EPILOBIUM MICROPHYLLUM, A. Rich.—Common in dry plains and valleys of E., C., and N. Waitaki Valley; Shag Valley; Maniototo Plain; Lake District; &c.

EPILOBIUM CRASSUM, Hooker.—Kurow Mountains (3,000ft.).

EPILOBIUM MACROPUS, Hooker.—Common by mountain-creeks and in upland runnels. Waipori; Old Man Range; Hector Mountains; higher valleys of Lake District.

EPILOBIUM ROSTRATUM, Cheeseman (MS.)—Naseby; Black's. In dry, shingly, and sandy stations.

EPILOBIUM PICTUM, Petrie. — Mountain valleys of C. St. Bathan's; Mount Pisa (3,000ft.); Old Man Range.

EPILOBIUM GRACILIPES, T. Kirk.—Dunedin; Naseby; Tapanui; &c.

MESEMBRYANTHEMUM AUSTRALE, Sol.—Common on clay cliffs of E. coast. Oamaru; Shag Point; Dunedin; &c.

TETRAGONIA TRIGYNA, Banks and Sol.—Not rare on E. coast. Dunedin, &c.

HYDROCOTYLE ELONGATA, A. Cunn.—Common in lowland bush.

HYDROCOTYLE AMERICANA, L.—Common in bush throughout the district.

HYDROCOTYLE ASIATICA, L.—Common in moist, scrubby, and open lands of E. and S.; less common in the interior.

HYDROCOTYLE MUSCOSA, R. Br.—Somewhat rare; in wet situations throughout. Taieri Plain; Nevis Valley; Lake Wanaka; Lake Te Anau.

HYDROCOTYLE DISSECTA, Hook. f.—Catlin's district.

HYDROCOTYLE NOVÆ-ZEALANDIÆ, DC.—Widely spread in moist grassy lands. Dunedin; Taieri Plain; Lakes Hawea and Wanaka; Catlin's; Southland.

HYDROCOTYLE MOSCHATA, Forst. — Common on rather dry banks and slopes throughout.

HYDROCOTYLE HYDROPHILA, Petrie.—Moist seaside stations in the E. and S. Wickliffe Bay (B. C. Aston); Bluff (B. C. Aston); Otago Heads; Tomahawk Lagoon.

POZOA EXIGUA, Hook. f. — Hector Mountains (5,000ft.); Mount Cardrona (5,000ft.). Apparently a local plant, but easily overlooked.

POZOA HAASTII, Hook. f.—Not rare on the mountains of C. and W. Mount Ida; Mount St. Bathan's; Mount Pisa; Clinton Saddle, Lake Te Anau (from 3,000ft.–4,500ft.).

POZOA RENIFORMIS, Hook. f.—Mountains east and west of Nevis Valley (3,000ft.).

POZOA TRIFOLIOLATA, Hook. f.—Not rare in forests of E. and S. Dunedin; Catlin's; Bluff Hill; &c.

POZOA HYDROCOTYLOIDES, Hook. f.—Kurow Mountains, and Mount St. Bathan's (4,000ft.). This plant has almost disappeared from these stations, apparently from the increasing dryness of the summer season, caused by the growing bareness of the ground.

POZOA (AZORELLA) NITENS, Petrie.—Lake Te Anau; Matukituki Valley.

CRANTZIA LINEATA, Nutt.—Common in swamps on E. and S. coasts. Rare inland: Waitahuna; Maniototo Plain.

APIUM AUSTRALE, Thouars.—Common on cliffs and banks of E. and S. coasts.

APIUM FILIFORME, Hook.—In same stations as the preceding, but less common. Also inland at Blacks, and Lowburn (Cromwell).

ERYNGIUM VESICULOSUM, Labill.—Along sea-coast north of Oamaru. I have not observed this plant south of the mouth of the Kakanui River.

OREOMYRRHIS COLENSOI, Hook. f.—Common in rather dry, open stations; rarer in the S. and S.W. Swampy Hill; Mihiwaka; Macrae's; Ngapara; Kurow; St. Bathan's; &c.

OREOMYRRHIS HAASTII (?), Hook. f.—Mount Cardrona (4,000ft.). I doubt if this species is truly distinct from the foregoing, which is a very variable plant.

OREOMYRRHIS RAMOSA, Hook. f.—Common on hill-slopes and in mountain valleys throughout. Dunedin; Outram; Speargrass Flat; Matukituki Valley; &c. A very variable plant. The fruits are sometimes glabrous and sometimes hispid, and they vary much in length and stoutness.

ACIPHYLLA SQUARROSA, Forst.—Not rare in the E. and S. Dunedin; Palmerston S.; Tuapeka, Maniototo, and Clutha Counties; &c. Now much less abundant than it was even twenty years ago. Seedlings are readily cropped by sheep and cattle, so that when old plants die off there are few young ones to take their place.

ACIPHYLLA COLENSOI, Hook. f.—Common in hilly and mountainous districts of C., S., and W. Dunedin; Waipori; Macrae's; &c. Less a lowland plant than the preceding. Ascends to nearly 4,000ft. on the mountains of C. and W.; descends to 600ft. near Dunedin.

ACIPHYLLA MONROI, Hook. f.—All high mountains of C. and W. (3,500ft.-6,000ft.). Mount Ida; Mount St. Bathan's; Old Man Range; and many western stations.

ACIPHYLLA DOBSONI, Hook. f.—Mount St. Bathan's, in shingle (6,000ft.).

ACIPHYLLA MONTANA, Armstrong.—Mountains near Mount Aspiring (4,000ft. and upwards).

ACIPHYLLA TRAILLII, T. Kirk.—Mount Ida Range (3,000ft.).

ACIPHYLLA KIRKII, Buchanan.—Hector Mountains, at 5,000ft. and upwards. I do not feel at all certain that this is distinct from *A. montana*, Armstrong.

ACIPHYLLA SIMPLEX, Petrie.—Mount Pisa and Mount Cardrona (6,000ft.).

LIGUSTICUM INTERMEDIUM, Hook. f.—Catlin's; Nugget Point; and Port Pegasus.

LIGUSTICUM HAASTII, F. von Mueller.—Mount Tyndall; Mount Bonpland (4,000ft. and upwards). Confined to the far west of the district.

LIGUSTICUM BREVISTYLE, Hook. f.—Kurow and Mount Ida Ranges; Speargrass Flat; Kawarau Gorge; hills east and west of Nevis Valley. Descends to 800ft. south of Alexandra.

LIGUSTICUM FILIFERUM, Hook. f.—Mountains north of Lake Hawea (4,000ft.).

LIGUSTICUM AROMATICUM, Banks and Sol.—Common in the E., C., and W. on the hills up to 4,500ft. Flagstaff Hill; Macrae's; Naseby; &c. A most variable plant, which may include more than one specific form. Like *L. brevistyle*, it is strictly diœcious.

LIGUSTICUM IMBRICATUM, Hook. f.—Mountains of C. and W., at 4,500ft. and upwards. Old Man Range; Dunstan Mountains; Mount Pisa; Hector Mountains; &c.

LIGUSTICUM ENYSII, T. Kirk.—Near Naseby (1,800ft.).

ANGELICA GINGIDIUM, Hook. f.—Common on moist banks and slopes. Now getting rather rare, as it is greedily eaten by stock.

ANGELICA DECIPIENS, Hook. f.—Probably not rare on the mountains of the W. Near Arrowtown; Mount Cardrona (5,000ft.); Mount Arnould; &c.

ANGELICA GENICULATA, Hook. f.—Not rare near E. coast on edge of bush. Dunedin, &c. I do not remember having observed this in the S. or the interior.

ACTINOTUS NOVÆ-ZEALANDIÆ, Petrie.—Blue Mountains (3,000ft.) and Stewart Island.

DAUCUS BRACHIATUS, Sieber.—Not rare in E. and N.E.; more common in dry stations in the interior.

ARALIA LYALLII, T. Kirk.—Paterson's Inlet.

PANAX SIMPLEX, Forst.—Not uncommon in forests of E., S., and W.

PANAX EDGERLEYI, Hook. f.—Rather rare in forests of the E. and S.

PANAX ANOMALUM, Hook. f.—Rare and local in E. and S.; more plentiful in the W. Waitati; Green Island; Lakes Te Anau and Wakatipu; &c.

PANAX LINEARE, Hook. f.—Clinton Valley (Te Anau).

PANAX CRASSIFOLIUM, Dcne. and Planch.—Common in forests of E., S., and W.

PANAX FEROX, T. Kirk.—Rare and local. Dunedin; Otepopo; Lake Wakatipu. Only in fertile, well-drained stations.

PANAX COLENSOI, Hook. f.—Common in forests of E. and S., and on the higher slopes of the western valleys; rare in the centre. Ascends to 4,000ft.

PANAX ARBOREUM, Forst.—Rather rare. Dunedin.

SCHEFFLERA DIGITATA, Forst.—Not rare in bottoms of valleys near E. coast. Dunedin; Catlin's; &c.

GRISELINIA LITTORALIS, Raoul.—Abundant in forests of E. and S.; more rare in C. and W.

LORANTHUS COLENSOI, Hook. f.—Chiefly, if not wholly, on *Fagus menziesii.* West Taieri; Catlin's; &c.

LORANTHUS FLAVIDUS, Hook. f.—On *Fagus cliffortioides*, in forests of the W. Queenstown; Matukituki; Hunter River; &c.

LORANTHUS MICRANTHUS, Hook. f.—Common on *Coprosma*, &c., in E. and S.

LORANTHUS DECUSSATUS, T. Kirk.—On *Fagus menziesii* and *Fagus fusca.* Tapanui; Hunter Valley; Lake Te Anau; &c.

TUPEIA ANTARCTICA, Cham. and Sch.—Not scarce in forests of E. and S. on *Pittosporum, Carpodetus*, &c.

VISCUM LINDSAYI, Hook. f.—Rare and local. Many spots near Dunedin, on *Myrsine* and *Melicope*.

VISCUM SALICORNIOIDES, A. Cunn.—Rare and local. Several spots near Dunedin (Anderson's Bay, Pelichet Bay, &c.), on *Leptospermum* (both species).

COPROSMA LUCIDA, Forst.—Common in forests of the S. and W. On the E. it hardly passes north of the mouth of the Taieri River. Lake Hawea; Lake Te Anau. Ascends to 1,100ft.

COPROSMA ROBUSTA, Raoul.—Rather rare on the E. seaboard. Horse Range; Dunedin; Kaitangata.

COPROSMA CUNNINGHAMII, Hook. f.—Dunedin. This has probably a wider distribution than I am aware of.

COPROSMA ROTUNDIFOLIA, A. Cunn. Common in bush. Ascends to 2,000ft.

COPROSMA RHAMNOIDES, A. Cunn. Common in bush; more rare in open inland valleys.

COPROSMA CRASSIFOLIA, Col.—Sparingly spread over the district, both in bush and in open country; most abundant near the sea. Dunedin; Otepopo; Kurow; Dunstan Gorge; &c.

COPROSMA PARVIFLORA, Hook. f.—Abundant in open scrub, and on the edges of forests. Ascends to 3,000ft.

COPROSMA PROPINQUA, A. Cunn.—Abundant in valley-bottoms of scrubby country and on the edges of bush. Ascends to 1,200ft. in Lake District.

COPROSMA FŒTIDISSIMA, Forst.—Not rare in bush. Dunedin (ascends here to 2,300ft.); Catlin's; Akatore; Seaward Bush; Lake Wakatipu.

COPROSMA COLENSOI, Hook. f.—Port Pegasus, at 200ft.; Whisky Gully, near Tapanui (B. C. Aston).

COPROSMA CUNEATA, Hook. f.—Not rare on the mountains (from 2,000ft. to 4,500ft.). Mount Cargill; Maungatua; Blue Mountains; Mount Ida; &c.

COPROSMA ACEROSA, A. Cunn.—Not rare in open scrub on the E. and S. Ascends to 2,000ft. A much-branched prostrate form is common on sandhills of E. and S., and more rare inland on clay banks.

COPROSMA LINARIIFOLIA, Hook. f.—Not rare in bush throughout; most common in the E. and S. Flowers much later than any of the other lowland species.

COPROSMA REPENS, Hook. f.—Not rare on the mountains. Rarely descends below 3,000ft. Maungatua; Hector Mountains; Mount Tyndall; Dunstan Mountains; &c.

COPROSMA VIRESCENS, Petrie.—Rare and local, but widely spread, chiefly on dry, fertile slopes. Otepopo; Dunedin; Kurow; Bendigo; Kaitangata; Bannockburn. Ascends to 1,500ft.

COPROSMA RUBRA, Petrie.—Rather rare on alluvial scrubby flats near E. coast. Dunedin; Catlin's district; &c.

COPROSMA AREOLATA, Cheeseman.—Not rare in bush. Dunedin; Otepopo; Hampden; Catlin's; Lake District. Has no great range in altitude.

COPROSMA PETRIEI, Cheeseman.—Abundant in the plains and drier valleys of the interior and N.; comes to coast in Waitaki Valley. Pukeuri; Maniototo Plain; Clutha Valley from lakes to Moa Flat; Five-Rivers Plain; &c.

COPROSMA SERRULATA, Hook. f.—Not rare on the mountains of C. and W. (from 2,500ft.–5,000ft.). Mount Ida; Mount St. Bathan's; Mount Cardrona; Mount Tyndall; Clinton Saddle; &c.

COPROSMA RIGIDA, Cheeseman.—Rare in bush near the E. coast. Dunedin; Saddle Hill.

COPROSMA RETUSA, Petrie.—Clinton Saddle, Te Anau.

NERTERA DEPRESSA, Banks and Sol.—Not rare in moist stations in E. and S.; much less frequent in valleys of interior. Usually below 1,800ft. Dunedin; Naseby; Old Man Range; Catlin's; &c.

NERTERA DICHONDRÆFOLIA, Hook. f.—Not rare in forests throughout.

NERTERA SETULOSA, Hook. f.—Common in open land and scattered scrub throughout. A very robust form grows in the valleys of the W. A distinctly proterogynous species.

GALIUM TENUICAULE, A. Cunn.—Rather rare in bush on the E. Waitati; Purakanui; Flagstaff Hill; Catlin's; &c.

GALIUM UMBROSUM, Forst.—Rather common in open stations and scattered scrub, throughout. Dunedin; Mount Ida; Speargrass Flat; &c. Ascends to 2,500ft.

ASPERULA PERPUSILLA, Hook. f.—Common in moist open stations. Dunedin; Catlin's; Maniototo Plain; &c.

OLEARIA OPERINA, Hook. f.—Sounds of W. coast, at and near sea-level.

OLEARIA ANGUSTIFOLIA, Hook, f.—The Neck, Stewart Island; Bluff Peninsula.

OLEARIA COLENSOI, Hook. f.—Paterson's Inlet; Clinton Saddle, Te Anau.

OLEARIA NITIDA, Hook. f.—Not rare in scrub on the E. and S. and along the Clutha Valley. Ascends to 1,200ft.

OLEARIA MACRODONTA, Hook. f.—Dunedin.

OLEARIA ILICIFOLIA, Hook. f.—Not rare in lowland bush and scrub of E. and S. Frequent in the valleys of the far W.

OLEARIA MOSCHATA, Hook. f.—Humboldt Mountains; Mount Tyndall; Clinton Saddle (3,000ft.-4,000ft.).

OLEARIA CYMBIFOLIA, Hook. f.—Not rare in valleys of C. and W. Mount Ida; Hector Mountains; Matukituki district; &c. (from 2,300ft. up to 4,000ft.).

OLEARIA AVICENNIÆFOLIA, Hook. f.—Common in bush and scrub in the E. and S.; more rare in valley-bottoms of C. and W. Dunedin; Catlin's; Bluff; Orepuki; Tuapeka Mouth; Roxburgh; Lake Wanaka; &c.

OLEARIA VIRGATA, Hook. f.—Not rare on moist declivities of E. and S.; most abundant in valleys and lower mountain slopes of C. and W. Dunedin; Catlin's; Roxburgh; &c.

OLEARIA FRAGRANTISSIMA, Petrie.—Rare and local. Dunedin (Vauxhall); Otago Heads; Catlin's.

OLEARIA ODORATA, Petrie.—Common on alluvial flats and lower slopes of interior. Sowburn; Manuherikia Valley; throughout Clutha Valley north of Moa Flat; Matukituki Valley; &c.

OLEARIA HECTORI, Hook. f.—Local, but usually plentiful where it grows. Kaitangata; Catlin's; Invercargill; Kawarau Gorge; Matukituki Valley (here a small tree, elsewhere a stout shrub).

CELMISIA HOLOSERICEA, Hook. f.—Mountains west of Te Anau (3,000ft. and upwards).

CELMISIA DENSIFLORA, Hook. f.—Rather rare in the N.E.; formerly plentiful. Mihiwaka; Pigroot; Kurow and Mount Ida Ranges; Mount St. Bathan's; &c. (800ft. to 3,000ft.). Will soon be all but exterminated through burning and the attacks of stock and rabbits.

CELMISIA DISCOLOR, Hook. f.—On the mountains of C. and W. Once abundant, but now getting rare. Mount Ida, Dunstan, and Old Man Ranges, and all high mountains more to W. (3,000ft.-5,500ft.).

CELMISIA HAASTII, Hook. f.—Abundant at 4,000ft. to 5,500ft. on the mountains of C. and W. Rock and Pillar Range is the most easterly station known to me.

CELMISIA LINDSAYI, Hook. f.—Sea-cliffs at Nugget Point and Catlin's district. I have also seen numerous living plants of this species brought by Mr. Henry Matthews, of Dunedin, from the neighbourhood of Lake Harris. These have a more robust habit than the sea-coast form.

CELMISIA SINCLAIRII, Hook. f.—Mountains at head of Matukituki Valley and of Lake Wakatipu (4,000ft.).

CELMISIA VERBASCIFOLIA, Hook. f.—Not rare on the lower hills of the eastern district. Oamaru (now extinct here); Horse Range; Flag Swamp; Macrae's (80ft.-2,000ft.). I have not seen this except in the N.E. district of Otago.

CELMISIA CORIACEA, Hook. f.—Now rare on the mountains and higher hills of the E., C., and W. Maungatua (2,500ft.); Kakanui Mountains; Rock and Pillar Range; Mount Arnould (Upper Hawea); hills west of Te Anau (800ft.-3,500ft.). This is rapidly disappearing before the attacks of rabbits and stock.

CELMISIA LYALLII, Hook. f.—Common on mountains of C. and W. (3,500ft. - 5,000ft.). Dunstan Mountains; Carrick Range; Mount Pisa, and all mountains of far W. Now becoming rather rare, thanks to the attentions of the rabbits.

CELMISIA VISCOSA, Hook. f.—Still fairly common on the mountains of the C. and W. at 4,000ft. and upwards. Rock and Pillar Range; Old Man Range; Hector Mountains; &c. Usually an abundant plant where it grows. Protected in winter by a mantle of snow.

CELMISIA PETIOLATA, Hook. f.—Clinton Valley, Te Anau.

CELMISIA LONGIFOLIA, Cass.—Abundant in moist open lands, and highly variable.

CELMISIA LARICIFOLIA, Hook. f.—Not rare on mountains of C. and W. at 4,000ft.-5,000ft. Old Man Range; Mount Ida; Mount St. Bathan's; and all mountains more to W.

CELMISIA HECTORI, Hook. f.—Now rare on mountains of W. Hector Mountains; Humboldt Mountains; Mount Tyndall; &c. I have not observed this east of the main valley of the Clutha.

CELMISIA SESSILIFLORA, Hook. f.—Abundant in wet localities on the mountains of the C. and W. (3,000ft.-5,000ft.). A most variable plant.

CELMISIA SESSILIFLORA, var. MINOR, Petrie.—Maungatua (3,000ft.).

CELMISIA BELLIDIOIDES, Hook. f.—Rather rare and local; on faces over which water flows or soaks. Mount Ida (3,000ft.); mountains near Arrowtown; Mount Tyndall.

CELMISIA GLANDULOSA, Hook. f.—Not rare in moist stations on mountains of W. Near Mount Aspiring (4,000ft.); Clinton Valley, Te Anau (1,500ft.).

CELMISIA WALKERI, T. Kirk.—Mountains near Mount Aspiring (3,000ft.). This may prove a form of *C. discolor*, which is a very variable species.

CELMISIA LINEARIS, Armstrong.—Maungatua (rare) (3,000ft.); Frazer Peaks, Stewart Island.

CELMISIA PROREPENS, Petrie.—Upper Waipori; Rock and Pillar Range; Old Man Range. Not seen elsewhere; a local plant, but plentiful where it grows (2,000ft.-4,500ft.).

CELMISIA RAMULOSA, Hook. f.—Mountains of W., at 5,000ft. and upwards. Hector Mountains; Mount Pisa; &c. Now a very rare plant except in the S.W.

CELMISIA BROWNII, F. R. Chapman.—Hector Mountains (5,000ft.); Clinton Valley, Te Anau (3,000ft.).

VITTADINIA AUSTRALIS, A. Rich.—Common, especially in the drier districts of the C. and N.; ascends to 3,000ft. Rapidly spreading in dry districts where the pastures have been eaten very bare.

LAGENOPHORA FORSTERI, DC.—Common throughout in open moist stations. A variable plant.

LAGENOPHORA PETIOLATA, Hook. f.—Local, but not rare; most common in open scrub. Dunedin; Catlin's; Lake Hawea; &c.

LAGENOPHORA PINNATIFIDA, Hook. f.—Rocky hummocks at Macrae's.

BRACHYCOME SINCLAIRII, Hook. f.—Common on all high mountains, and ascending to 5,000ft. Much more rare in lowlands of N.E.

Brachycome pinnata, Hook. f.—Not uncommon in the C. and N.E. Kurow; Ngapara; Kyeburn; Naseby; Cambrians; &c.

Brachycome thomsoni, T. Kirk. — Sea-cliffs near Green Island; north coast of Stewart Island. Apparently confined to seaside stations.

Abrotanella inconspicua, Hook. f.—Common on all high mountains at 4,000ft.–6,000ft.; most easterly station, Rock and Pillar Range.

Abrotanella cæspitosa, Petrie.—Clarke's Diggings, Mount Ida (3,000ft.). This species is abundant at 5,000ft. at the sources of Broken River, N. Canterbury.

Cotula coronopifolia, L.—Abundant by lagoons near the sea on the E. and S.

Cotula australis, Hook. f.—Neighbourhood of Oamaru. I think this is, in Otago at least, an introduced plant. It has spread greatly about Oamaru in recent years.

Cotula atrata, Hook. f.—Shingly slopes on Mount Kyeburn and Mount St. Bathan's, at 4,000ft.

Cotula pectinata, Hook. f.—Common on the mountains, from 3,000ft. to 5,000ft. Descends to the Waitaki River valley at Kurow, and to 1,500ft. at Maniototo Plain.

Cotula perpusilla, Hook. f.—Not uncommon in the drier plains of the N.E. and C. Kurow; Duntroon; Maniototo Plain; Cromwell; &c. Ascends to 3,000ft. on Old Man Range.

Cotula dioica, Hook. f.—Not rare near the coast on the E. and S.; much more rare inland.

Cotula squalida, Hook. f.—Rare in the E.; more common in alluvial valleys of C., W., and S. Ahuriri; St. Bathan's; Lakes Wakatipu and Te Anau; &c.

Cotula maniototo, Petrie.— Rare in the E.; much more common in lagoons and wet spots of C. and S. Kakanui Mouth; Maniototo Plain; Nevis Valley; Mossburn; Te Anau; &c.

Cotula goyeni, Petrie.—Mount Pisa and Hector Mountains (about 6,000ft.).

Cotula minuta, Forst.—Not rare in wet spots in the Lake District. Luggate; Albertown; Pembroke.

Craspedia fimbriata, DC.—Common throughout in open stations.

Craspedia alpina, Backhouse.—Not rare on all high mountains at 5,000ft. and upwards. Old Man Range; Hector

Mountains; Mount Pisa; Mount Cardrona; &c. Near Naseby, forms intermediate between *C. fimbriata* and *C. alpina* are abundant. They are densely clothed with cottony tomentum, and have yellow heads. I doubt if the species are truly distinct.

CASSINIA FULVIDA, Hook. f.—Common throughout on moist clay hills and slopes.

CASSINIA VAUVILLIERSII, Hook. f.—As widely spread as the preceding, but less common. Ranges from sea-level to 3,500ft.

OZOTHAMNUS GLOMERATUS, Hook. f.—Widely spread, though not common, in lowlands of E. and C. Dunedin; Kurow; Tuapeka district; Lake District.

OZOTHAMNUS MICROPHYLLUS, Hook. f.—Widely spread, but local; grows chiefly in crevices of dry rocky faces. Cape Saunders; Kurow; Mount Ida; Alexandra; Kawarau Gorge (near Arrowtown); &c. Ascends to 3,000ft. at Mount Ida.

OZOTHAMNUS DEPRESSUS, Hook. f.—On shingly river-flats of Kurow Range. Duntroon; Otiake; Kurow; Upper Kyeburn. I have observed this nowhere else in Otago. (I have found this species also in the bed of the Tukituki, near Waipawa. I mention this as I have not seen it recorded as occurring in the North Island.)

RAOULIA AUSTRALIS, Hook. f.—Not uncommon in shingly river-flats and dry terraces of the C. Kyeburn; Maniototo Plain; Dunstan Terraces; Lake District. The typical form occurs also at Sandy Mount and at Catlin's, close to the sea. Ascends to 2,000ft.

RAOULIA TENUICAULIS, Hook. f.—Common by sides of shingly creeks and on wet gravelly grounds of E., C., and N. Waitati; Macrae's; Waitahuna; Lake District; &c.

RAOULIA HAASTII, Hook. f.—Kyeburn Crossing. I have seen this nowhere else in Otago. It flowers early, and I have never been able to gather good specimens, but I think there can be no doubt as to the accuracy of the identification.

RAOULIA MONROI, Hook. f.—Common throughout in dry, light soil, and very variable. Dunedin (on sandhills); Maniototo Plain; St. Bathan's; Kurow; Kawarau Gorge; &c. Ascends to 3,000ft., and probably much higher if *R. apice-nigra*, T. Kirk, be a form of this species, as it may well be. Forms of what is undoubtedly *R. monroi* are common near Rowburn and at St. Bathan's, at 1,500ft. to 2,500ft., which I cannot separate from Mr. Kirk's species.

RAOULIA SUBULATA, Hook. f —Not rare on the mountains of the C. and W. at 4,500ft. and upwards. Old Man Range; Hector Mountains; Mount Pisa; Mount Tyndall; &c.

RAOULIA EXIMIA, Hook. f.—Mount Ida Range, 4,000ft. I have seen this nowhere else in Otago. It is the species so well known in Canterbury as the "vegetable sheep."

RAOULIA HECTORI, Hook. f.—Formerly common on all high mountains of C., now rapidly dying off from the drying of the ground through burning and close cropping. Mount St. Bathan's; Old Man Range; Hector Mountains; Mount Pisa; Ben Lomond; &c. (4,500ft.-6,000ft.).

RAOULIA GLABRA, Hook. f.—Rather rare on dry hills of E. and C. Signal Hill (Dunedin); Waipori; Lake Hawea. Ascends to 2,000ft.

RAOULIA SUBSERICEA, Hook. f.—Common on hills and plains of C. and N., and spreading. Macrae's; Maniototo Plain; St. Bathan's; Ida Valley; Cromwell; Lake Wanaka; &c. Ascends to 2,500ft.

RAOULIA GRANDIFLORA, Hook. f.—Not rare, on all high mountains at 4,000ft. and upwards. Rock and Pillar Range; Mount Ida; Mount St. Bathan's; &c.

RAOULIA BRYOIDES, Hook. f.—Mount Pisa and Hector Mountains, at 5,000ft. - 6,000ft. Otago specimens differ in several respects from those from Marlborough, but there is no doubt of the identity of the species.

RAOULIA PETRIENSIS, T. Kirk.—Mount Ida and Mount St. Bathan's (4,000ft.-5,000ft.). This plant has been seen nowhere else than in these two neighbouring habitats.

RAOULIA APICE-NIGRA, T. Kirk.—Mount Pisa (4,000ft.). Forms which I refer to *R. monroi*, and which are almost identical with this, are common at much lower elevations near the Kawarau River and at St. Bathan's and Sowburn.

RAOULIA PARKII, J. Buchanan.—Common in shingly riverbeds and flats of the Lake District. What seem forms of this also ascend the western mountains to 4,000ft. A very glutinous form abounds on the top of the Old Man Range, forming extensive matted patches.

RAOULIA GOYENI, T. Kirk.—Mount Rakiahua (Stewart Island). I have had specimens of this from Mr. Goyen, F.L.S., and also from Mr. A. C. Purdie.

RAOULIA YOUNGII, Hook. f.—Rather rare at 5,500ft. to 6,600ft. on the mountains of the W. Mount Pisa; Hector Mountains. It seems not to extend east of the main valley of the Cluthe.

RAOULIA MCKAYI, J. Buchanan.—This plant is not a *Raoulia*, but a small alpine form of *Gnaphalium traversii*, Hook. f. It keeps its character very constantly throughout the South Island, and may be a distinct species. Ranges from 3,000ft. to 4,500ft.

GNAPHALIUM TRINERVE, Forst.—Common on the E. and S. coasts.

GNAPHALIUM TRAVERSII, Hook. f.—Not rare throughout, and common in moist stations in the C., S., and W. Signal Hill and Swampy Hill (Dunedin); Waipori; Maniototo Plain; Lake District; Waipahi; Lumsden; Te Anau.

GNAPHALIUM LUTEO-ALBUM, Linn.—Common in dry open stations; very variable, and spreading rapidly.

GNAPHALIUM COLLINUM, Labill.—Abundant on dry hills and terraces of C. and N.E.; more rare in E. and S.

GNAPHALIUM PALUDOSUM, Petrie.—Boggy spots in many parts of interior; abundant where it grows. Maniototo Plain; Rock and Pillar slopes; Speargrass Flat; Cromwell; &c. Ascends to 3,500ft.

HELICHRYSUM BELLIDIOIDES, Hook. f.—Common on clay banks throughout.

HELICHRYSUM FILICAULE, Hook. f.—Common. Ascends to 4,000ft.

HELICHRYSUM GRANDICEPS, Hook. f.—Rather rare on mountains of N. and W. (3,500ft.–5,000ft.). Mount Ida; Mount St. Bathan's; Mount Pisa; Mount Cardrona; Mount Arnould; &c.

HELICHRYSUM PURDIEI, Petrie.—Very rare on the coast at Otago Harbour. Now almost extinct in this its only known habitat.

HAASTIA SINCLAIRII, Hook. f.—Rare on mountains of far W., at 5,000ft. to 6,500ft. Hector Mountains; Mount Bonpland; Mount Arnould.

ERECHTITES PRENANTHOIDES, DC.—Common in forest clearings of E. and S. The weed that usually grows up after fires.

ERECHTITES ARGUTA, DC.—Common near the coast; more rare inland.

ERECHTITES QUADRIDENTATA, DC.—Not uncommon on dry banks and rocky faces.

ERECHTITES GLABRESCENS, T. Kirk.—Rather uncommon, but widely spread in open moist bush. Dunedin; Te Anau; Hunter River; &c.

Erechtites diversifolia, Petrie.—Rather rare, but widely spread in open grassy lands. Outram; Naseby; Mount Iron (Lake Wanaka); Arrowtown.

Senecio bellidioides, Hook. f.—Common on the lower hills of the E. and S. Ascends to 4,500ft. on mountains of C. and W.

Senecio haastii, Hook. f.—Not rare on the lower plains and hills of the interior. Maniototo Plain; Manuherikia Plain; Lake District. Ascends to 3,000ft.

Senecio lautus, Forst.—Common on the E. and S. coasts; more rare on plains and lower mountains of the interior. Mount Ida; Mount Pisa; Old Man Range; &c. Ascends to 3,000ft.

Senecio lyallii, Hook. f.—Not rare in mountain valleys of C. and W. Ascends to 4,500ft., but descends to sea-level at the south of Stewart Island. Hector Mountains; Mount Ida; Mount Pisa; Clinton Valley; &c.

Senecio sciadophilus, Raoul. — Not rare in bush near E. coast. Goodwood; Otago Heads and Peninsula; Dunedin; Saddle Hill.

Senecio elæagnifolius, Hook. f.—Rare and local in bush, but of wide range. Mount Cargill; Blue Mountains (2,500ft.); lowlands of Stewart Island.

Senecio rotundifolius, Hook. f.—North and east coasts of Stewart Island, and south-west coast of Otago. Abundant close to the beach.

Senecio cassinioides, Hook. f.—Rare in mountain valleys of N. and N.W. West slopes of Kurow Mountains; mountains east of Mount Aspiring. Ascends to 4,000ft.

Senecio robusta, J. Buchanan.—Not rare on the mountains of the far W. at 4,000ft. and upwards. Ben Lomond; Mount Bonpland.

Senecio muelleri, T. Kirk.—Islets north-east of Stewart Island. Not known from the main islands.

Microseris forsteri, Hook. f.—Not rare on open lands. Dunedin; Macrae's; Maniototo Plain; Tapanui; &c.

Crepis novæ-zealandiæ, Hook. f.—Not rare on clay banks and cuttings in C. and W. Shag Valley; Maniototo Plain; Cromwell; &c.

Taraxacum dens-leonis, Desf.—Rather rare in the E. and S.; much more common in the C. and W.

Sonchus oleraceus, L.—Not rare on cliffs by the seaside. The introduced form abounds in ill-cultivated lands.

ORROSTYLIDIUM SUBULATUM, Berggren.—Rather rare in wet peaty stations in the E. and S. Swampy Hill (Dunedin); Maungatua; Inch-Clutha; Catlin's; Blue Mountains; Bluff Hill. Ranges from sea-level to 3,000ft.

FORSTERA SEDIFOLIA, L. f.—Common on the mountains of the far W. Longwood Range; Clinton Saddle (3,000ft.); Frazer Peaks (Stewart Island).

FORSTERA BIDWILLII, Hook. f.—Not rare in mountain swamps in the E. and S. Swampy Hill (Dunedin); Maungatua; Catlin's; Blue Mountains. Ranges from 20ft. to 3,000ft. I have not observed this on the mountains of the N., C., or W. The plant here referred to may be *F. tenella*, Hook. f. Mr. Brown, A.L.S., of Kew, considers that both belong to one species, a view in which I am disposed to concur.

DONATIA NOVÆ-ZEALANDIÆ, Hook. f.—Not rare in mountain swamps of the E. and S. Maungatua; Blue Mountains; low flats west of Paterson's Inlet. Ranges from 20ft.–3,000ft.

PHYLLACHNE CLAVIGERUM, Hook. f.—Not rare on the mountains of the W. Hector Mountains; Mount Pisa; Mount Cardrona; &c. (4,000ft.–6,000ft.).

PHYLLACHNE COLENSOI, Hook. f.—Common in the higher mountains at 4,000ft.–5,500ft. Rock and Pillar Range; Mount Ida; Hector Mountains; Mount Pisa; &c.

PHYLLACHNE HAASTII, Berggren.—Maungatua (3,000ft.).

WAHLENBERGIA GRACILIS, DC.—Common in dry open stations up to 3,000ft.

WAHLENBERGIA SAXICOLA, DC. — Common throughout at 1,000ft.–3,500ft.

LOBELIA ROUGHII, Hook. f.—Broken shingle-slopes of Mount Ida and Mount St. Bathan's (3,500ft.–5,000ft.).

LOBELIA LINNÆOIDES, Petrie.—Not uncommon on mountains of C. and W. Mount Ida; Hector Mountains; &c. (3,000ft.–4,500ft.).

PRATIA ANGULATA, Hook. f.—Not uncommon on wet open lands, and very variable. Var. DELTA: Old Man Range (3,000ft.–4,000ft.). Var. GAMMA: Sandhills at Catlin's.

PRATIA MACRODON, Hook. f.—Rare and local on the mountains of the W. Mount Cardrona and Hector Mountains (4,000ft.).

SELLIERA RADICANS, Cav.—Common by seaside in E. and S.; rare inland and much reduced in size, as at Lakes Wanaka and Te Anau. Ascends to 1,000ft.

GAULTHERIA ANTIPODA, Forst.—Most abundant on heathy hills and lowlands throughout.

GAULTHERIA RUPESTRIS, Br.—Common in mountain valleys, on banks of streams. Kurow Mountains; Mount Ida; Hector Mountains; &c.

PERNETTYA TASMANICA, Hook. f.—Hector Mountains (4,000ft.). Mount Bonpland.

CYATHODES ACEROSA, Br.—Not rare near the E. and S. coasts. Dunedin; Bluff Hill; &c.

CYATHODES EMPETRIFOLIA, Hook. f.—Common on swampy ground on hills and lowlands of E. and S. Swampy Hill, Dunedin; Maungatua; Inch-Clutha; Blue Mountains; &c. Ranges from sea-level to 3,000ft.

CYATHODES COLENSOI, Hook. f.—Neighbourhood of Naseby; Waipori. A local plant, almost confined to the N.E. highlands, at 2,000ft.–3,000ft.

LEUCOPOGON FRAZERI, A. Cunn.—Abundant throughout in open heathy lands up to 3,000ft.

PENTACHONDRA PUMILA, Br.—Abundant on the mountains of the C. and W., and on the hills of the E. Descends almost to sea-level at Inch-Clutha and Catlin's, and ascends to 5,000ft. on the mountains of C. and W.

ARCHERIA TRAVERSII, Hook. f.—Occurs sparingly in the valleys of the far W. Clinton Valley; valleys of Reece and Hollyford.

DRACOPHYLLUM MENZIESII, Hook. f.—On upper edge of bush on mountains west of Lakes Wakatipu and Te Anau (3,000ft.–3,500ft.).

DRACOPHYLLUM STRICTUM, Hook. f.—Clinton Saddle, Lake Te Anau (3,000ft.).

DRACOPHYLLUM LONGIFOLIUM, Br.—Common in the E. and S., especially near the sea. Ascends to 3,000ft. on Maungatua.

DRACOPHYLLUM URVILLEANUM, A. Rich.—Not rare in the Lake District and in the lower valleys of the C. Lakes Wakatipu, Hawea, and Te Anau; Mount Ida; Tapanui. I have not always been able to distinguish this clearly from the preceding species.

DRACOPHYLLUM UNIFLORUM, Hook. f.—Not uncommon in mountain valleys of C. and W. at 2,500ft.–4,000ft. Mount Ida; Hector Mountains; &c.

DRACOPHYLLUM ROSMARINIFOLIUM, Forst.—Formerly common on the mountains of the C. and W. at 3,500ft.–5,000ft.

Mount Ida; Mount St. Bathan's; Mount Pisa; Hector Mountains; &c. Like the preceding, this is now becoming rare, owing to fires and desiccation consequent on close cropping of the grasses and other edible plants by sheep and rabbits.

DRACOPHYLLUM MUSCOIDES, Hook. f.—Common on the bare mountain-tops of the C. and W. (4,000ft.–6,000ft.). Old Man Range; Hector Mountains; Mount Pisa; &c.

DRACOPHYLLUM PROSTRATUM, T. Kirk.—Maungatua and Blue Mountains (3,000ft.), and Clinton Valley (1,000ft.).

MYRSINE URVILLEI, A. DC.—Common in forests of E. and S.; more rare in W.

MYRSINE DIVARICATA, A. Cunn.—Not rare on well-drained lowland slopes and flats of E. and S. Dunedin; Catlin's; Invercargill; Lake Te Anau. Ascends to 1,800ft. on Mount Cargill.

MYRSINE NUMMULARIA, Hook. f.—Mountain valleys of E. central district; rare. Mount Ida and Mount St. Bathan's (3,000ft.–4,000ft.).

MYRSINE CHATHAMICA, F. von M.—Southern corner of Stewart Island. I have specimens from this locality gathered by Mr. G. M. Thomson, F.L.S.

SAMOLUS LITTORALIS, Br.—Common on tidal flats on the E. and S.

PARSONSIA ALBIFLORA, Raoul.—Common in forests of the E. and S.

PARSONSIA ROSEA, Raoul.—Not rare in the Upper Clutha Valley: Clyde; Cromwell; &c. Much more rare towards the E.: Dunedin.

LOGANIA TETRAGONA, Hook. f.—Not rare on bare mountain-tops of C. and W. Old Man Range; Mount Pisa; Ben Lomond; Mount Bonpland (4,500ft.–6,000ft.).

GENTIANA MONTANA, Forst.—Not uncommon in open moist lands throughout, except the N.E. Ranges from near sea-level at Catlin's and Invercargill to 3,000ft. on the Blue Mountains.

GENTIANA PLEUROGYNOIDES, Griesb.—Abundant on the mountains from 3,500ft.–5,500ft., but descending to 1,100ft. at Hawea Flat.

GENTIANA SAXOSA, Forst.—Rather local, but not rare in the E. and S. Catlin's (100ft.); Bluff; Macrae's (1,800ft.); Maungatua; and Maniototo Plain.

LIPAROPHYLLUM GUNNII, Hook. f.—Muddy flats at Paterson's Inlet, Stewart Island.

Myosotis pulvinaris, Hook. f.—Lofty mountains of W. and N.W. Mount Pisa; Old Man Range; Hector Mountains; Mount Cardrona; &c. (4,500ft.-6,000ft.). I cannot distinguish *M. hectori*, Hook. f., from this, and agree with Mr. N. E. Brown that it is not distinct from the present species.

Myosotis spathulata, Forst.—In bush on Inch-Clutha. I have observed this nowhere else in Otago.

Myosotis antarctica, Hook. f.—Not rare on the uplands and mountains of the N. and C.; more uncommon in the S. Kurow Flats; Mount Ida; Mount Cardrona; Crown Range. Ascends to 4,000ft.

Myosotis australis, Br.—Not rare on dry hill-sides of C. and N. Mount Ida; Mount St. Bathan's; Speargrass Hill; &c.

Myosotis forsteri, Roem. and Sch.—Not rare in the western valleys. Clinton Valley; head of Lake Wakatipu; Upper Hawea; &c.

Myosotis capitata, Hook. f.—Rare on spray-washed cliffs of E. and S. coasts. Dunedin; Catlin's; Paterson's Inlet. The blue-flowered form occurs near Dunedin; elsewhere the flowers are pale, nearly white.

Myosotis traversii, Hook. f.—Rare on the mountains of the N.W. Mount Arnould, Hawea (6,000ft.).

Myosotis cheesemanii, Petrie.—Mount Pisa and Hector Mountains (6,000ft.).

Myosotis albo-sericea, Hook. f.—Dry rocky stations near Cromwell; now nearly extinct in this its only known habitat.

Myosotis goyeni, Petrie.—Rocky slopes at Arrowtown and Lake Hawea; shingly terraces of Cardrona Valley.

Exarrhena macrantha (?), Hook. f.—Rather rare on steep rocky faces on the mountains of the N.W. Mount Aspiring; Mount Cardrona; Mount Bonpland (5,500ft.-6,000ft.). I think it not unlikely that this plant is distinct from the true *E. macrantha*, though at Kew they are regarded as of the same species.

Tetrachondra hamiltonii, Petrie.—Rather rare on moist lowlands of E. and S. Plateau between Lee Stream and Strath Taieri; Hindon School-grounds; Waipahi; Invercargill. Ascends to 1,800ft.

Convolvulus tuguriorum, Forst.—Common in bush and scrub.

CONVOLVULUS SOLDANELLA, L.—Common in sandy stations on the E. and S. coasts.

CONVOLVULUS ERUBESCENS, Br.—Not rare in dry stations in C. and N.E. Roxburgh; Clyde; Cromwell; Hamilton's; Kurow; &c.

DICHONDRA REPENS, Forst.—Not rare in E. and C. Dunedin; Oamaru; Cromwell; &c.

DICHONDRA BREVIFOLIA, J. Buchanan.—Not rare in the N.E. and E. central districts. Duntroon; Horse Range; Strath Taieri; Maniototo Plain; &c.

CUSCUTA, sp.—Green Island; head of Lake Hawea. I have not been able to determine the species, which may be introduced.

SOLANUM AVICULARE, Forst.—Not rare in dry fertile stations near E. coast. Otepopo; Dunedin; Kaitangata.

SOLANUM NIGRUM, L.—Rather rare in the valleys of C. Kawarau Gorge; Pembroke. This may quite well be introduced at these stations.

MIMULUS REPENS, Br.—Common in saline marshes and lagoons on E. and S. coasts. Waikouaiti; Dunedin; Taieri Mouth; &c.

MIMULUS RADICANS, Hook. f.—Not rare in moist lowlands of E., S., and C. Blueskin; Maungatua; Waipahi; Kelso; Naseby; Speargrass Flat; Lumsden; Lake Te Anau; &c.

GRATIOLA NANA, Benth.—Local, but not rare in shallow lagoons and wet spots on the plateau of the E. Lee Stream; Barewood; Strath Taieri; Macrae's.

GRATIOLA PERUVIANA, R. Br.—Lake Te Anau.

GLOSSOSTIGMA ELATINOIDES, Benth.—Rare in Otago; more common in Southland. Strath Taieri; Maniototo Plain; Lumsden; Te Anau; &c.

GLOSSOSTIGMA SUBMERSA, Petrie.—Tidal shores of Lake Waihola. This flowers in February. I have gathered it only once, though I have kept a look-out for it for several years.

LIMOSELLA AQUATICA, L., var. TENUIFOLIA.—Common in moist situations, especially in the interior.

LIMOSELLA CURDEYANA, F. von M.—Manuherikia Valley, near Black Horse Hotel. I owe the identification of this plant to Mr. T. Kirk, F.L.S. It is most likely introduced there. I have met with it nowhere else.

VERONICA SALICIFOLIA, Forst.—Abundant. Dunedin; Tokomairiro; Lawrence; Lake District; Catlin's; &c.

VERONICA TRAVERSII, Hook. f.—Not uncommon on hills of S., C., and W. Waipori; Blue Mountains; Lake Te Anau; Lake Wanaka; &c.

VERONICA ELLIPTICA, Forst.—Abundant on E. and S. coasts.

VERONICA LÆVIS, Benth.—Valleys and hill-slopes of far W.; Lakes Wakatipu and Te Anau. I do not feel quite certain of the identification of this species.

VERONICA BUXIFOLIA, Benth.—Common on the lower hills and mountain valleys of E., C., and S. Swampy Hill, Dunedin; Maungatua; Waipori; Blue Mountains; Eweburn Creek; Mount Ida; &c. Ascends to 3,000ft.

VERONICA PINGUIFOLIA, Hook. f.—Common on dry high mountain-slopes of C. and W. Mount Ida (4,000ft.); Mount St. Bathan's; Mount Arnould; &c.

VERONICA PIMELEOIDES, Hook. f.—Common on rocky faces in upper valleys of Taieri and Clutha. Speargrass Flat; Clyde; Cromwell; Queenstown; Mount Ida; &c. Ascends to 3,000ft.

VERONICA LYCOPODIOIDES, Hook. f.—Humboldt Mountains.

VERONICA HECTORI, Hook. f.—Hector Mountains (4,000ft.).

VERONICA SALICORNIOIDES, Hook. f.—Mount Ida; Waipori; Maungatua (2,000ft.–3,000ft.).

VERONICA CUPRESSOIDES, Hook. f.—Lammerlaw (3,000ft.). I have not seen this plant wild, but plants taken from above station are growing at Lawrence.

VERONICA EPACRIDEA, Hook. f.—Mount Arnould (5,000ft.).

VERONICA MACRANTHA, Hook. f.—Clinton Saddle, Te Anau (3,000ft.).

VERONICA LINIFOLIA, Hook. f.—Arrowtown (3,000ft.).

VERONICA LYALLII, Hook. f.—Not rare in the lower mountain valleys of C., S., and W. Mount Ida; Queenstown; Te Anau; Mataura Village (the lowest station known to me).

VERONICA BIDWILLII, Hook. f.—Not rare in mountain valleys of C. and N.W. Mount Ida; head of Lake Hawea; &c. (2,300ft.–3,000ft.).

VERONICA CATARACTÆ, Forst. Common in valleys of far W. Clinton Valley; Milford Sound; &c.

VERONICA CANESCENS, Kirk.—Common in dry plains of C. Moa Flat; Maniototo Plain; Hawea Flat; Five-Rivers Plain; &c.

VERONICA PETRIEI, T. Kirk (= *Mitrasacme petriei*, J. Buchanan).—Mount Bonpland (4,500ft.).

PYGMÆA PULVINARIS, Hook. f.—Not rare on tops of lofty mountains of N. and W. (4,500ft.-6,000ft.). Kurow Mountains; Mount St. Bathan's; Mount Pisa.

OURISIA MACROPHYLLA, Hook.—Flagstaff Hill, Dunedin; Paterson's Inlet, Stewart Island.

OURISIA MACROCARPA, Hook. f.—Clinton Saddle, Lake Te Anau (3,000ft.).

OURISIA COLENSOI, Hook. f.—Clinton Valley, in bush (1,800ft.). This species has been identified for me at Kew. Mr. N. H. Brown, in his report, remarks that two species are mixed up in the description in Sir J. D. Hooker's Handbook.

OURISIA SESSILIFLORA, Hook. f.—Not uncommon on lofty mountains of far W. Mount Bonpland (4,500ft.); Hector Mountains (5,000ft.); Clinton Saddle, Te Anau, at 3,500ft.

OURISIA CÆSPITOSA, Hook. f.—Common in mountain valleys of N. and W. (3,000ft.-5,000ft.). Mount Ida; Dunstan Mountains; Old Man Range; Hector Mountains; Mount Cardrona; &c.

OURISIA PROREPENS, Petrie.—Mount Bonpland (4,500ft.).

EUPHRASIA REVOLUTA, Hook. f.—Not rare on lofty mountains of W. and N.W., at 5,000ft. and upwards. Hector Mountains; Mount Tyndall; Mount Arnould.

EUPHRASIA ANTARCTICA, Benth.—Common in N., C., and W. (300ft.-4,500ft.). Kurow; Mount St. Bathan's; Crown Range; Mount Cardrona (4,500ft.); &c.

EUPHRASIA REPENS, Hook. f.—In mountain-bogs; probably not rare. Mount Kyeburn (3,500ft.); Maungatua; Blue Mountains.

UTRICULARIA COLENSOI, Hook. f.—Boggy stations at Te Anau, and head of Paterson's Inlet.

MYOPORUM LÆTUM, Forst.—Common near the sea in the E. and S.

MENTHA CUNNINGHAMII, Benth.—Common in open lands. West Taieri; Strath Taieri; Maniototo; Roxburgh; &c.

PLANTAGO UNIFLORA, Hook. f.—Rare near E. and S. coasts. Tomahawk Lagoon, Dunedin; Paterson's Inlet; Te Anau. What may be a mountain form of this occurs in abundance on Mount Kyeburn, Mount Ida, and Dunstan Mountains, at 3,000ft.-4,000ft.

PLANTAGO BROWNII, Rapin.—Rather rare on wet mountain stations of E., C., and N. at 3,000ft.-4,000ft. Mount Ida; Blue Mountains; Maungatua; Hector Mountains.

Plantago lanigera, Hook. f.—Not uncommon, but local on mountains of C. and N.W. Old Man Range; Hector Mountains; Mount Pisa; &c. (4,000ft.–5,500ft.).

Plantago spathulata, Hook. f.—Not rare on moist uplands of C. and N.W. Naseby; Mount St. Bathan's; mountains of Lake District. Ascends to 3,000ft.

Plantago raoulii, Decaisne.—Common in moist lowlands.

Chenopodium triandrum, Forst.—Common on E. and S. coasts; rare inland. Cromwell; Ophir; &c.

Chenopodium urbicum, L.—Common by waysides, &c.

Chenopodium glaucum, L., var. ambiguum.—Common at seaside, and in saltish stations inland. Dunedin; Oamaru; Roxburgh; Cromwell; Maniototo Plains; &c.

Chenopodium carinatum (?), Br.—Kawarau River. My specimens have two stamens, a condition not rare in Australian forms of the species. Probably introduced.

Chenopodium detestans, T. Kirk.—Common in dry lowlands of C. and N. Maniototo Plain; Cromwell; Lake Hawea; &c.

Suæda maritima, Dumortier.—Common by salt lagoons of E. and S. coasts.

Atriplex patula, L.—Common by waysides, &c.

Atriplex billardieri, Hook. f.—Sandy shores of Paterson's Inlet.

Atriplex buchanani, T. Kirk.—Common in saltish stations of C. and W.; rare near E. coast. Green Island Beach; Maniototo Plain; Ida Valley; Alexandra; Cromwell; &c.

Salsola australis, Br. (?).—Otiake River; Lowburn; Bannockburn. Spreading rather rapidly, and most likely introduced.

Salicornia indica, Willd. (?).—Abundant on low flats near the sea on the E. and S.

Scleranthus biflorus, Hook. f.—Abundant up to 4,000ft.

Polygonum aviculare, L.—Abundant by waysides and on edges of fields. Most likely introduced.

Muhlenbeckia adpressa, Labill.—Abundant in valleys of C. and N.E. Lake District; Kurow; Sowburn; &c.

Muhlenbeckia complexa, Meisner.—Abundant in bush and scrub.

Muhlenbeckia axillaris, Hook. f.—Lower Waitaki Valley; Maniototo Plain; throughout the Clutha Valley; Lake District; &c.

MUHLENBECKIA EPHEDROIDES, Hook. f.—Rather rare and local. Kurow; Awamoko; Roxburgh.

RUMEX FLEXUOSUS, Forst.—Abundant in N. and C.; more rare elsewhere.

RUMEX NEGLECTUS, T. Kirk.—Port Molyneux; Catlin's; Bluff; Paterson's Inlet.

PIMELEA TRAVERSII, Hook. f.—Rather rare on mountains of C. and N. Mount St. Bathan's; Mount Ida (2,000ft.–3,000ft.).

PIMELEA ARENARIA, A. Cunn.—Not rare on sandhills of E. and S. coasts.

PIMELEA PROSTRATA, Vahl.—Common in open lands.

PIMELEA LYALLII, Hook. f.—Common in the Lower Waitaki and Upper Clutha Valleys; Kurow; Manuherikia Valley; Lake District; &c. I have not seen this in the Taieri basin.

PIMELEA SERICEO-VILLOSA, Hook. f.—Abundant in Clutha Valley north of Cromwell to Lake Hawea. I have not seen this outside this very limited district.

KELLERIA DIEFFENBACHII, Hook.—Not uncommon throughout. Signal Hill; Lawrence; Tapanui; Bluff; Catlin's; &c.

KELLERIA LYALLII, Hook. f.—Not rare on lofty mountains of C. and N.W., at 5,000ft.–6,000ft. Dunstan Mountains; Old Man Range; Hector Mountains; Mount Pisa; Mount Cardrona; &c.

KELLERIA VILLOSA, Berggren.—Mount Ida (4,000ft.).

EXOCARPUS BIDWILLII, Hook. f.—Head valleys of Eweburn Creek, near Naseby. I have observed this plant nowhere else in Otago.

EUPHORBIA GLAUCA, Forst.—Common on sandhills of E. and S. coasts.

PARATROPHIS MICROPHYLLUS, Hook. f.—Not uncommon in bush in E. and S. Dunedin; Hampden; Catlin's; West Taieri; &c.

FAGUS MENZIESII, Hook. f.—Not rare on hills of E. and S. Mount Cargill; West Taieri; Catlin's; Tapanui; &c.

FAGUS FUSCA, Hook. f.—Common in the higher valleys of the far W. Lakes Hawea, Wanaka, and Wakatipu.

FAGUS CLIFFORTIOIDES, Hook. f.—Common in the higher valleys of the far W. Lakes Hawea, Wanaka, Wakatipu, and Te Anau.

FAGUS SOLANDRI, Hook. f.—Common in lower valleys and hill slopes W. of the Lake District.

Urtica incisa, Poiret.—Not rare thoughout; chiefly in bush and scrub.

Urtica ferox, Forst.—Rather rare in bush on the E. Oamaru; Otepopo; Saddle Hill; Otago Peninsula; &c. I have not observed this plant far inland.

Parietaria debilis, Forst.—Rather rare, chiefly in bush and scrub, in the E. and N. Kurow; Oamaru; Otago Peninsula; Lake Wanaka.

Australina pusilla, Gaud.—Not rare in bush in the E. and S. Dunedin; Catlin's; Chasland's Mistake; &c.

Libocedrus bidwillii, Hook. f.—Mount Cargill (800ft.–2,000ft.).

Podocarpus ferruginea, Don.—Not rare in forests of E. and S.

Podocarpus nivalis, Hook. f.—Mountains of W. and N.W. Mount Arnould (3,500ft.); Clinton Saddle.

Podocarpus totara, A. Cunn.—Common in lowland forests of E. and S.

Podocarpus hallii, T. Kirk.—Mount Cargill.

Podocarpus spicata, Br.—Not rare in lowland forests of E. and S. Dunedin; West Taieri; Catlin's. Now largely cleared off by cutting for timber.

Podocarpus dacrydioides, A. Rich.—Not rare in wet lowland and hilly forests of E. and S. Dunedin; Kaitangata; Catlin's; Southland; &c.

Dacrydium cupressinum, Sol.—Common in forests of E. and S.

Dacrydium colensoi, Hook. f.—Mount Cargill (2,000ft.).

Dacrydium laxifolium, Hook. f.—Rather rare in bleak swampy stations of S. and W. Stewart Island; Clinton Valley (900ft.); Blue Mountains (3,000ft.).

Dacrydium bidwillii, Kirk.—Rare in bleak mountain swamps. Maungatua (3,000ft.); Waipori; The Desert, Lake Te Anau (800ft.).

Phyllocladus alpinus, Hook. f.—Not rare on the lower mountains of E., C., and W. Mount Cargill; Mount Ida (3,000ft.); forests of Lake District from Hawea to Te Anau.

Earina mucronata, Lindley.—Common on tree-stems in forests of E., S., and W. Dunedin; Catlin's; Bluff; Te Anau; &c.

Earina autumnalis, Hook. f.—Rather rare near the E. coast. Dunedin; Nugget Point.

DENDROBIUM CUNNINGHAMII, Lindley.—Rather rare on trees and rocks in forests of E. and S. Port Chalmers; Leith Valley; Catlin's.

SARCOCHILUS ADVERSUS, Hook. f. — Very rare on rocks and trees in bush in vicinity of Dunedin. Sawyer's Bay; Pine Hill (on *Griselinia littoralis*, Raoul).

GASTRODIA CUNNINGHAMII, Hook. f.—Not rare in forests of E., S., and W. Dunedin; Pine Hill; Maungatua; Lake Te Anau; Lake Wakatipu; Bluff; Stewart Island. This seems much more plentiful in the mossy forests of the W. Elsewhere it is more easily overlooked.

GASTRODIA MINOR, Petrie.—Scrub at Opoho Creek, near Dunedin. Not at all easy to detect, and not very plentiful.

ADENOCHILUS GRACILIS, Hook. f. — Moss-carpeted forests of far W. Lakes Wakatipu and Te Anau. The long, stout rootstocks usually lie in moss, and have no connection with the soil. The way in which they absorb food is well worth investigating.

CORYSANTHES TRILOBA, Hook. f. — Sparingly found in the forests of the E. and S. Dunedin; Bluff Hill.

CORYSANTHES OBLONGA, Hook. Forests of Catlin's district. Apparently a very rare plant in Otago.

CORYSANTHES ROTUNDIFOLIA, Hook. f.—Not rare in the forests of the E. and S. North-east Valley; Waitati Creek; Catlin's; Heriot (in boggy ground); Bluff.

CORYSANTHES RIVULARIS, Hook. f. — Rare in deep shady valleys in bush. Head valleys of Water of Leith; Bluff.

CORYSANTHES MACRANTHA, Hook. f.—Not uncommon in moist stations in bush and scrub. Dunedin; Kaitangata; Bluff; Lawrence; Pembroke; &c.

MICROTIS PORRIFOLIA, Sprengel.—Common in dry, open stations, and very variable in size and robustness.

CALADENIA MINOR, Hook. f.—Not uncommon in scrub and heath in the E. and S. Dunedin; Manuka Creek; Catlin's; Bluff; &c.

CALADENIA LYALLII, Hook. f.—Swampy Hill, Dunedin; Maungatua; Blue Mountains. Ascends to 3,000ft.

CHILOGLOTTIS CORNUTA, Hook. f.—Bluff; Maungatua. Ascends to 3,000ft.

CHILOGLOTTIS BIFOLIA, Hook. f.—Not uncommon in moist heathy stations of E. and S. Swampy Hill; Maungatua; Catlin's; Invercargill; Bluff. Ranges from 3,000ft. to near sea-level.

PTEROSTYLIS BANKSII, Br.—Not rare in bush near the E. and S. coasts. Dunedin; Port Molyneux; Catlin's; Bluff.

PTEROSTYLIS GRAMINEA, Hook. f.—Not rare in moist open stations in C., E., and S. Dunedin; Kaitangata; Owaka Valley; Naseby.

PTEROSTYLIS FOLIATA, Hook. f.—Rather rare on the uplands of the E. Dunedin (Signal Hill); Milburn; Tuapeka West.

PTEROSTYLIS MUTICA, Br.—Not uncommon on dry uplands of C. and E. Horse Range; Lee Flat; Naseby; Cambrian; St. Bathan's.

LYPERANTHUS ANTARCTICUS, Hook. f.—Swampy Hill; Maungatua (2,500ft.), in peaty stations. A rare and local plant.

THELYMITRA LONGIFOLIA, Forst.—Common in moist stations, especially in the E. and S. Dunedin; Port Molyneux; Milton; Lawrence; Maniototo Plain; &c.

THELYMITRA PULCHELLA, Hook. f.—Not rare in the S.; much more uncommon in the E. Dunedin (Signal Hill); Invercargill; Bluff.

THELYMITRA UNIFLORA, Hook. f.—Not rare in wet lowlands of E. and S. Swampy Hill; Maungatua; Port Molyneux; Catlin's; Invercargill.

PRASOPHYLLUM NUDUM, Hook. f.—Common in open lands. Dunedin; Naseby; Kaitangata; Catlin's; Naseby; &c.

LIBERTIA IXIOIDES, Sprengel.—Not rare on the edge of bush and in scrub in the E.: Dunedin; Horse Range; Wangaloa; &c. Smaller forms are sparingly found in the interior: Macrae's; Maniototo Plain; &c.

LIBERTIA MICRANTHA, Hook. f.—Southern corner of Stewart Island, and forests west of Lake Te Anau.

HYPOXIS PUSILLA, Hook. f.—Otepopo. I have not seen this elsewhere. As it flowers very early, and is very inconspicuous, it is easy to overlook.

TYPHA ANGUSTIFOLIA, L.—Common in ponds and sluggish streams. Lake Waihola; Taieri Plain; Cromwell; Lake Hayes; Lake Hawea; Waiareka Valley; &c.

RUPPIA MARITIMA, L.—Common in salt lagoons and tidal streams on the E. Waikouaiti; Tomahawk; Taieri Plain; Lake Waihola; &c. It grows abundantly in the Waipahi River in perfectly fresh water.

ZANNICHELLIA PALUSTRIS, L.—Waikouaiti Lagoon.

LEPILÆNA BILOCULARIS, T. Kirk (m.s.).—Waikouaiti; Lake Waihola; Taieri Plain.

ZOSTERA NANA, Roth. — Common on submerged and tidal mudbanks in E. and S. Dunedin; Bluff; Stewart Island.

RHIPOGONUM SCANDENS, Forst.—Common in the forests of the E. and S. Dunedin; Catlin's; Bluff; &c.

CALLIXENE PARVIFLORA, Hook. f.—Common in bush in the S. and W. Catlin's; Seaward Bush; Te Anau; Stewart Island.

CORDYLINE AUSTRALIS, Hook. f.—Common in most parts, and ascending to 3,000ft. in the interior.

DIANELLA INTERMEDIA, Endl.—Not rare in scrub near the E. coast. Dunedin; Akatore; &c.

ASTELIA NERVOSA, Banks and Sol.—Not rare on the lower uplands of the E. and S. Hills round Dunedin; Circle Hill; Tuapeka district; Blue Mountains; Waipahi; &c.

ASTELIA LINEARIS, Hook. f.—Not rare on the mountains of the C. and W. at 4,000ft. and upwards, but descending almost to sea-level in the south of Stewart Island. Hector Mountains; Mount Bonpland; Clinton Saddle (3,000ft.); Pegasus Inlet (20ft.).

ASTELIA GRANDIS, Hook. f.—Common in the forests of the E., S., and W. Dunedin; Port Molyneux; Catlin's; Invercargill; Bluff; Te Anau; &c.

ARTHROPODIUM CANDIDUM, Raoul.—Not uncommon in dry bushy and open stations throughout. Dunedin (Opoho Valley); West Taieri; Black's; Macrae's; Tapanui; Cromwell.

ANTHERICUM HOOKERI, Col.—Common on moist hill and mountain slopes throughout. Dunedin; Macrae's; Naseby; Clyde; Bannockburn; Blue Mountains; Waipahi; &c.

PHORMIUM TENAX, Forst.—Common in lowland swamps and on banks of rivers and streams, especially in the E. and S.

PHORMIUM COLENSOI, Hook. f.—Not rare in the C. and S. on hills of 1,000ft. and upwards. Lake Hawea; Waipori Road (from Lawrence); Waitepeka; Upper Owaka (3,000ft.); &c.

HERPOLIRION NOVÆ-ZEALANDIÆ, Hook. f.—Not rare in lowlands and lower uplands of E. and S. Ranges from sea-level to 3,000ft. Maungatua; Waipori; Clinton; Catlin's; Invercargill; Bluff; &c.

JUNCUS VAGINATUS, Br.—Rather rare and local. Sawyer's Bay; Strath Taieri; Alexandra South; Lumsden; Paterson's Inlet.

Juncus australis, Hook. f.—Common in swamps of E., C., and S. Macrae's; Waipori; Tuapeka West; Tapanui; Waipahi; Catlin's; &c.

Juncus communis, E. Meyer.—Abundant in wet open stations throughout.

Juncus planifolius, Br.—Not rare in the E. and S. Dunedin; Inch-Clutha; Catlin's; &c.

Juncus bufonius, L.—Abundant in wet stations.

Juncus novæ-zealandiæ, Hook. f.—Abundant in wet stations. Ascends to 2,000ft.

Juncus lamprocarpus, Ehr.—Abundant in wet stations in E. and S.; less common in interior. Sawyer's Bay; Green Island; Tuapeka district; Cromwell; Catlin's; Invercargill.

Juncus brevifolius, T. Kirk.—Not rare in lowland and upland wet stations of C. and S. Ranges from 3,500ft. to sea-level. Clarke's Diggings; Naseby; Lake Wanaka; Lake Te Anau; Port Molyneux; Catlin's.

Juncus tenuis, Willd.—Dunedin. Most likely introduced.

Juncus pauciflorus, Br.—Waitati; Tokomairiro district. May quite well be an introduction here.

Juncus articulatus, Ehrhart.—Lake Waihola. Most likely introduced.

Rostkovia gracilis, Hook. f.—Common, at 5,000ft.-7,000ft. on the mountains of the W. Hector Mountains; Mount Arnould; Mount Pisa; Mount Bonpland; &c.

Luzula campestris, DC.—Abundant.

Luzula australasica, Steudel.—Not rare near the E. coast and in the lowlands of the S. Lawyer's Head; Brighton; Beaumont; &c.

Luzula pumila, Hook. f.—Common on mountains from 4,000ft.-6,500ft. Rock and Pillar Range; Old Man Range; Mount Ida, &c.

Luzula racemosa, Desv., var. traversii, Buchenau.—Not rare on all mountains of C. and W., at 3,000ft.-5,000ft. Old Man Range; Mount Ida; Mount Pisa; &c.

Luzula picta, A. Rich.—Not rare in the E. and C. Lawyer's Head; Tapanui; &c. I do not see how this can be kept distinct from *L. campestris*, DC., and insert it only because it is recognised as a good species in Buchenau's monograph of the *Juncaceæ*.

Luzula cheesemanii, Buchenau.—Not rare on the mountains of the C. Mount St. Bathan's; Dunstan Range; Mount Pisa; &c. I have, from various parts of the interior, several other

forms of this most difficult genus that, when better known, may prove distinct species. They have been placed in the hands of Professor Buchenau for determination and description.

LEPTOCARPUS SIMPLEX, A. Rich.—Common in sandy and swampy saline stations on the E. and S. coasts.

HYPOLENA LATERIFOLIA, Benth.—Not uncommon in wet stations in the S. Inch-Clutha; Catlin's; Otaraia River; Invercargill; &c.

GAIMARDIA SETACEA, Hook. f.—Swampy mountain stations in the E. and S. Maungatua; Blue Mountains (3,000ft.).

ALEPYRUM PALLIDUM, Hook. f.—Rare in swampy mountain stations in C. and S. Maungatua; Mount Kyeburn; Clinton Saddle; Blue Mountains.

CENTROLEPIS VIRIDIS, T. Kirk.—Maungatua; Blue Mountains; Lake Te Anau (3,000ft.–700ft.).

CENTROLEPIS MINIMA, T. Kirk, var.—Shores of Lake Te Anau.

SCHŒNUS AXILLARIS, Hook. f.—Bluff; Stewart Island.

SCHŒNUS PAUCIFLORUS, Hook. f.—Common in bleak upland valleys. Hindon; Maniototo uplands; Lake District (3,000ft.); Pembroke; &c.

SCHŒNUS CONCINNUS, Hook. f.—Not rare in wet, saltish stations near the E. and S. coasts. Waikouaiti; Otago Heads; Catlin's River; &c.

CARPHA ALPINA, Br.—Not rare on wet hills in the S. and on the mountains of C. and W. Maungatua; Old Man Range; Blue Mountains. This descends almost to sea-level at the Bluff and Stewart Island.

SCIRPUS MARITIMUS, L.—Rather rare on the E. coast. Oamaru; Waikouaiti; Otago Heads. I have not observed it south of the last station.

SCIRPUS PUNGENS, Vahl.—Common on salt mud-flats of E. and S. coasts. Dunedin; &c.

ISOLEPIS NODOSA, Br.—Abundant on salt sandhills and sandy shores of E. and S. Dunedin; &c.

ISOLEPIS PROLIFER, Br.—Invercargill.

ISOLEPIS RIPARIA, Br.—Abundant on the E. and S. coasts; less common in wet stations in the interior and W.

ISOLEPIS CARTILAGINEA, Br.—Bluff and Stewart Island.

ISOLEPIS AUCKLANDICA, Hook. f.—Not uncommon in wet stations on the mountains of C. and W. Old Man Range (4,000ft.); Mount Kyeburn; and mountains of Lake District.

ISOLEPIS BASILARIS, Hook. f.—Not uncommon in wet stations of moderate elevation in the middle part of the Clutha Valley. Beaumont; Roxburgh; Speargrass Flat; &c.

ISOLEPIS INUNDATUS, Br.—Not uncommon in wet valleys in scrub near the E. and S. coasts. Dunedin; Port Molyneux; Catlin's.

HELEOCHARIS SPHACELATA, Br.—Head of Paterson's Inlet.

HELEOCHARIS ACUTA, Br., var. PLATYLEPIS.—Common in wet stations throughout. Dunedin; Cromwell; Kelso; Catlin's; &c.

HELEOCHARIS GRACILLIMA, Hook. f.—Not rare in the interior and S. Maniototo Plain; Te Anau; &c.

HELEOCHARIS ACICULARIS, L.—Lake Te Anau.

DESMOSCHENUS SPIRALIS, Hook. f.—Abundant on sandhills of E. and S. coasts.

CLADIUM GLOMERATUM, Br.—Not rare in wet scrubby valleys. Signal Hill; Catlin's; Heriot; Pembroke; &c. Rather local.

CLADIUM JUNCEUM, Br.—Not uncommon on the S. and W., mostly near the seaside. Bluff; Te Anau; &c.

GAHNIA PROCERA (?), Forst.—South of Stewart Island; Lake Te Anau; and valleys of S.W. region.

LEPIDOSPERMA TETRAGONA, Labill.—Abundant on wet clay hills of E. and S. Dunedin; Bluff; &c.

OREOBOLUS PUMILIO, Br.—Not rare in wet mountain stations. Maungatua; Mount Kyeburn (3,500ft.); Dunstan Mountains; Old Man Range; Blue Mountains; Bluff. Descends to sea-level at Inch-Clutha.

OREOBOLUS STRICTUS, Berggren.—Not rare on wet hills of E. and S. Swampy Hill; Maungatua; Mount Kyeburn; Hector Mountains (4,000ft.); Blue Mountains. Descends to sea-level at Inch-Clutha.

UNCINIA LEPTOSTACHYA, Raoul.—Common in bush and scrub in the E. and S. Dunedin; Kaitangata; Catlin's; &c.

UNCINIA SINCLAIRII, Boott.—Not rare in the C. and N.W. Eweburn Creek, Naseby; Black's; Hector Mountains (4,000ft.); Mount Cardrona; &c. Descends to 1,200ft.

UNCINIA COMPACTA, Br., var. DIVARICATA.—Not uncommon in the higher valleys of C. and W. Mount Ida; Mount Tyndall; head of Lake Hawea; Clinton Valley and Saddle; &c. Ranges from 1,000ft.–5,000ft. The forms found at high elevations are very short and depauperated. My *U. clarkei* is probably only a form of this species. It was

carefully compared with the type of *U. compacta* by Mr. C. B. Clarke, F.R.S., F.L.S., before I published it, and was by him pronounced to be new. Later materials convinced him that it was only a form of the present species, as was also another form, for which he proposed the name *U. petriei.*

UNCINIA AUSTRALIS, Persoon.—Common in bush throughout the district. Dunedin; Catlin's; Lake Hawea; &c.

UNCINIA FERRUGINEA, Boott.—Not rare in forests of E. and S. Dunedin; Catlin's; Stewart Island; &c.

UNCINIA CÆSPITOSA (?), Boott.—Not rare in bush in the E., S., and W. Dunedin; Catlin's; Lake Te Anau; &c.

UNCINIA RUPESTRIS, Raoul.—Common on clay hills and open stations of E. and S. Dunedin; Akatore; Kaitangata; Waipori; Blue Mountains; &c. Up to 3,000ft.

UNCINIA FILIFORMIS (?), Boott.—Rather rare on mountains of C. and W. Hector Mountains; Maungatua; &c.

UNCINIA BANKSII, Boott.—Rather rare and local in bush in the E. and S. Dunedin; south of Stewart Island.

UNCINIA RUBRA, Boott.—Common in open lands of E. and S. Dunedin; Maungatua; Kelso; Clinton; Catlin's; Bluff; &c.

UNCINIA PURPURATA, Petrie.—Rather rare in the E.; more common on mountains of N.W. Signal Hill; Swampy Hill; Maungatua; Macrae's; Horse Range; Mount Cardrona; Mount Tyndall; &c.

UNCINIA RIGIDA, Petrie.—Common in scrubby and open lands of E., S., and S. central districts. Waitati; Tokomairiro; Tuapeka; Miller's Flat; Akatore; Kaitangata; &c. This plant, which has been referred by different authors to *U. rubra*, Boott, and *U. riparia*, Br., still seems to me as distinct as any species of the genus that is to be found in the colony. It is far more distinct from any of its congeners than *U. ferruginea* is from *U. australis.*

UNCINIA RIPARIA, Br.—Not uncommon in bush and scrub in the E., S., and W. Dunedin; Catlin's; Lake Hawea; Lake Te Anau; &c. To this may belong my *U. laxiflora*, which is, however, quite unlike typical specimens of Brown's plant sent me by Baron von Mueller, as well as the figure of the latter in the "Flora Tasmaniæ." In my view, Bentham has included more than one species in his character of *U. riparia*, Br., in the "Flora Australiensis."

UNCINIA TENELLA, Br.—Clinton Valley; Matukituki Valley.

CAREX PYRENAICA, Wahl.—Common on all the mountains of C. and W. at 5,000ft. and upwards. Old Man Range; Hector Mountains; Mount Cardrona; Mount Pisa; Mount Arnould.

CAREX ACICULARIS, Boott.—Old Man Range, near head of Obelisk Creek (3,500ft.).

CAREX INVERSA, Br.—Rather uncommon in the C. and S. Ida Valley; Maniototo Plain; Strath Taieri; Catlin's.

CAREX COLENSOI, Boott.—Common in dry uplands of E., C., and S. Kurow; Maungatua; Blue Mountains; Lake Wanaka; Maniototo Plain; Lumsden; &c.

CAREX ECHINATA, Murray.—Not uncommon in lowland and mountain swampy stations. Romahapa; Port Molyneux; Catlin's; Blue Mountains; Lake Te Anau; Hector Mountains (5,000ft.).

CAREX TERETIUSCULA, Goodenough.—Rather rare in the E., C., and S. Strath Taieri; Sowburn; Cromwell; Catlin's.

CAREX VIRGATA, Solander.—Common in boggy and swampy stations throughout.

CAREX APPRESSA, Br.—Common near the E. and S. coasts. Dunedin; Catlin's; also at Lakes Te Anau and Hawea.

CAREX VULGARIS, Fries., var. GAUDICHAUDIANA, Boott.—Common in wet stations throughout. Ranges from sea-level (Lake Waihola) to 5,000ft. (Hector Mountains).

CAREX TESTACEA, Solander.—Common throughout the drier parts of the district. Waikouaiti; Dunedin; Lawrence; Maniototo Plain; mountains at Lake Wanaka; Mount Cardrona (4,000ft.); &c. Long confounded by colonial botanists with *C. raoulii*, Boott, a mistake that led me to describe the true *C. raoulii*, Boott, as a new species—my *C. goyeni*. Mr. T. F. Cheeseman, F.L.S., was the first to recognise the true *C. testacea* of Solander.

CAREX TERNARIA, Forst.—Common from sea-level to 4,000ft. Dunedin; Old Man Range; &c.

CAREX RAOULII, Boott.—Rather rare in open and scrubby valleys of C. and W. Mount Ida; head of Lake Wakatipu; Lake Wanaka; &c.

CAREX LUCIDA, Boott.—Common in lowlands of E., C., and S. Dunedin; Waipahi; Maniototo Plain; &c. Ascends to 2,500ft.

CAREX PUMILA, Thunberg.—Common on sandy shores of E. and S.

CAREX FORSTERI, Wahl.—Not rare in woodlands of E. and S. Dunedin; Catlin's; Horse Range; Clinton Valley. In the

last station only a peculiar variety, identical with Cheeseman's *C. cinnamomea*, occurs.

CAREX PSEUDOCYPERUS, Br.—Not rare in swamps of E., C., and S. Inch-Clutha; Catlin's; Waipori; Lake Wakatipu. Ascends to 2,000ft.

CAREX FLAVA, L.—Not rare in wet stations throughout. Otago Heads; Catlin's; Maniototo Plain; Lake Wanaka. Ascends to 3,000ft. at Clarke's Diggings.

CAREX BREVICULMIS, Br.—Common in dry open stations. Saddle Hill; Flagstaff Hill; &c. Ascends to 4,000ft. on Mount St. Bathan's, &c.

CAREX TRIFIDA, Cavanilles.—Rather rare on the E. and S. coasts. Otago Harbour; Hooper's Inlet; Catlin's; Stewart Island.

CAREX NEESIANA, Endl.—Not rare in the E. and S.; much more rare in C. and N. Dunedin; Otago Heads; Catlin's; Horse Range; Roxburgh; &c.

CAREX DISSITA, Solander.—Not uncommon in wet forest and open valleys of E. and S.; rarer in N.W. Dunedin; Catlin's; Invercargill; Macrae's (1,800ft.); Lakes Wanaka and Wakatipu.

CAREX BUCHANANI, Berggren.—Common in the Upper Clutha basin and the W.; rare in the E. Lake Waihola; Balclutha; Cromwell; Lake Te Anau; &c.

CAREX DIPSACEA, Berggren.—Not uncommon in pools and shallow lagoons of E., E. central, and S. districts. Waikouaiti; Maniototo Plain; Manuherikia Plain; Waipahi; Lumsden; &c.

CAREX COMANS, Berggren.—Not rare in drier open uplands of E. central district. Waipori; Hyde; Kyeburn Creek; &c. My *C. cheesemanii* is doubtless a form of this. Berggren's figure, which I had before me when the latter was described, is not at all characteristic of the prevailing Otago forms of the species.

CAREX LAGOPINA, Wahl.—Not rare in lofty mountains of W. and N.W., at 4,000ft.–6,000ft. Hector Mountains; mountains east of Mount Aspiring; head of Lake Wakatipu; &c. My *C. parkeri* is the same plant. I have lately found this at the sources of Broken River, Canterbury.

CAREX KALOIDES, Petrie.—Common in the upper Taieri basin; more rare in the Clutha basin. Balclutha; Strath Taieri; Maniototo Plain; St. Bathan's; Speargrass Flat; &c Ascends to 2,000ft.

CAREX MUELLERI, Petrie (= *C. viridis*, mihi, a name previously used).—Not uncommon on the mountains of the C. and N.W. Rough Ridge; Clark's Diggings; Carrick Range; Nevis Valley; Cardrona Valley; &c. Ascends to 4,000ft.

CAREX WAKATIPU, Petrie.—Common on the mountains of the C. and N.W. Mount Ida; Mount St. Bathan's; Hector Mountains; Ben Lomond; Mount Cardrona; &c. (from 3,000ft.–5,000ft.).

CAREX LONGICULMIS, Petrie.—Glory Cove, Stewart Island.

CAREX LITTOROSA, Bailey (= *C. littoralis*, Petrie, a name previously used).—Common on mudflats of E. and S. coasts. Dunedin; Bluff; Paterson's Inlet.

CAREX UNCIFOLIA, Cheeseman.—Not uncommon on the mountains and in the higher valleys of the N.W. Mount Cardrona (4,000ft.); Nevis Valley; Arrowtown.

CAREX RESECTANS, Cheeseman.—Common in the dry plains of the interior. Gimmerburn; Ida Valley; Albertown; &c.

CAREX PETRIEI, Cheeseman.—Not uncommon in the higher valleys of the N. and W. Mount Ida; Dunstan Mountains; Hector Mountains; Mount Cardrona. Ranges from 700ft. at Te Anau to 4,500ft.

CAREX BERGGRENI, Petrie.—Rather rare on the mountains of the C. Mount Pisa (5,000ft.); Old Man Range; Mount Kyeburn (3,300ft.).

CAREX KIRKII, Petrie.—Common on the mountains of the C. and N.W.; rarer towards the E. Macrae's; Nevis Valley; Old Man Range; Hector Mountains; Mount Pisa (1,800ft.–4,500ft.).

CAREX THOMSONI, Petrie.—Not rare on the summits of the highest mountains of the N.W. Old Man Range; Hector Mountains; Mount Pisa. Ranges from 4,500ft. to 6,500ft.

CAREX HECTORI, Petrie.—Old Man Range (5,000ft.).

CAREX NOVÆ-ZEALANDIÆ, Petrie.—Shores of Lake Te Anau.

EHRHARTA COLENSOI, Hook. f.—Clinton Saddle, Lake Te Anau (3,000ft.).

EHRHARTA THOMSONI, Petrie.—Paterson's Inlet and head of Port Pegasus, Stewart Island.

MICROLÆNA STIPOIDES, Br.—Dunedin; Kelso; Moa Flat; Speargrass Flat; head of Lake Hawea; Invercargill; Stewart Island. It has been alleged that this grass will not stand frost, but at the Speargrass Flat stations it grows most luxuriantly, though the frosts are very severe, and last for several months.

MICROLÆNA AVENACEA, Hook. f.—Common in forests throughout. Dunedin; Catlin's; Invercargill; Lake Hawea; Lake Te Anau.

MICROLÆNA POLYNODA, Hook. f.—Dunedin, at various stations in the Leith Valley.

ALOPECURUS GENICULATUS, L.—Common in wet stations throughout up to 2,000ft. Dunedin; Catlin's; Kelso; Maniototo Plain; Lake Wanaka; Lake Te Anau; &c.

HIEROCHLOE REDOLENS, Br.—Common in moist open stations.

HIEROCHLOE ALPINA, Roem. and Schultz.—Not rare on wet hills and the higher mountains. Maungatua; Macrae's; Rock and Pillar Range; Waipori; Blue Mountains; Clinton Valley; &c. Descends to sea-level at Inch-Clutha and Catlin's.

ZOYSIA PUNGENS, Willd.—Not rare on low terraces of Upper Clutha. Alexandra; Cromwell; Bendigo; Albertown.

ECHINOPOGON OVATUS, Beauv.—Not uncommon in dry lowland stations. Dunedin; Beaumont; Lake Wanaka; Arrowtown; &c.

STIPA SETACEA, Br.—Kawarau River; Firewood Creek, Cromwell; Kurow; Duntroon; Wharekuri. This is an Australian grass, and is most probably introduced in these stations.

DICHELACHNE CRINITA, Hook. f.—Common throughout in dry, open lowland stations. Dunedin; Lawrence; Cromwell; &c.

APERA ARUNDINACEA, Hook. f.—Rare and local in the E. Horse Range; Dunedin; Kaitangata.

AGROSTIS ANTARCTICA, Hook. f.—Head of Clinton Valley, Lake Te Anau.

AGROSTIS CANINA, L.—Abundant in C., W., and N.; more rare in E. and S. Naseby; Nevis Valley; Cromwell; &c.

AGROSTIS PARVIFLORA, Br.—Town Belt, Dunedin. I have not seen this elsewhere in Otago, and am of opinion that it is introduced in the Dunedin district.

AGROSTIS MUSCOSA, Kirk.—Abundant on wet hills and uplands of E. and S. Hindon; Waipori; Macrae's; Blue Mountains; &c. Ranges from 1,500ft. to 3,000ft.

AGROSTIS MUELLERI, Benth.—Abundant on the mountains of N., C., and W., at 4,000ft. and upwards. Mount Kyeburn; Mount Ida; Mount St. Bathan's; Hector Mountains; Mount Pisa; Mount Cardrona; &c.

AGROSTIS TENELLA, Petrie.—Macrae's; head of Lake Wakatipu.

AGROSTIS DYERI, Petrie.—Mountains east of Hunter River.

DEYEUXIA FORSTERI, Kunth.—Abundant in moist lowland stations. Dunedin; Maniototo Plain; Waipori; Lumsden; Lake Te Anau; &c.

DEYEUXIA STRICTA, Colenso.—Shores of Lake Te Anau. This is most probably only a variety of the foregoing species, growing in stations sodden with water.

DEYEUXIA PILOSA, A. Rich.—Not rare in the mountain valleys of the far W. Hunter River; Matukituki Valley; Clinton Valley.

DEYEUXIA BILLARDIERI, Kunth.—Not uncommon on sandhills of E. and S. coasts. Shag Point; Otago Heads; Dunedin Beach; Catlin's; Stewart Island.

DEYEUXIA SETIFOLIA, Hook. f.—Rare and local on the central mountains. Hector Mountains; Old Man Range. At 3,500ft.–4,000ft.

DEYEUXIA AVENOIDES, Hook. f.—Common on uplands and lower mountain slopes throughout. Swampy Hill; Waipori; Mount St. Bathan's; Hunter River; &c. Ascends to 4,000ft.

DEYEUXIA QUADRISETA, Br.—Common in the district round Dunedin; more rare in C. and W. Lake Wakatipu; Dunedin. Almost confined to scrubby lands.

DEYEUXIA SCABRA, Benth.—Mount Pisa (3,500ft.); Swampy Hill. Most likely introduced.

DEYEUXIA LEPTOSTACHYA, T. Kirk (MS.).—Catlin's; Stewart Island. Perhaps a var. of *D. billardieri*, Kunth.

ARUNDO CONSPICUA, Forst.—Common in moist open lowland stations.

DANTHONIA CUNNINGHAMII, Hook. f.—Not rare on moist banks on E. and S. Dunedin; Waipori; Stewart Island.

DANTHONIA RAOULII, Steudel.—Most abundant on uplands and lower hills throughout. Dunedin (100ft.); Waipori; Waipahi; Invercargill; Blue Mountains; Hector Mountains; &c. In the C. and N. this does not descend nearly so low as it does in the E. and S.

DANTHONIA FLAVESCENS, Hook. f.—Common on the mountains of the far W., at 4,000ft. and upwards. Mountains east of Lake Hawea and west of Lake Wanaka. Descends to 3,000ft. at Clinton Saddle. The eastern stations mentioned in Mr. Buchanan's work on the New Zealand

Grasses are given in error. He confounded robust forms of *D. raoulii* with the present species.

DANTHONIA SEMIANNULARIS, Br.—Abundant in open lands throughout, and very variable.

DANTHONIA PILOSA, Br.—Signal Hill; Heriot; Kelso.

DANTHONIA BUCHANANI, Hook. f.—Matukituki Valley.

DANTHONIA NUDA, Hook. f.—Common in the drier lowlands and on dry hills of E., C., and N. Macrae's; Kurow; Strath Taieri; Lakes Wanaka and Hawea; Tapanui. *Danthonia thomsoni*, Buchanan, is identical with this. I can vouch for this, as, through the kindness of Sir J. D. Hooker, I have been able to compare a spikelet of the original plant collected by Colenso with specimens of Buchanan's species, which I was the first to collect in Otago. Sir J. D. Hooker did not notice that there were two pencils of hairs on the flowering glume. As they overlap, they would naturally be taken for a single pencil. When a dissecting-needle is slipped in and the edge of the glume raised the two pencils are at once seen. Sir Joseph did not happen to do this, and so described the glume incorrectly as having a single pencil of hairs.

DANTHONIA OVATA, Buchanan, var.—Clinton Saddle (2,500ft.). If this is a form of Buchanan's species the latter has been very poorly described. He did not collect it himself, and most likely had indifferent material to work on. The present plant differs from *D. australis*, Buchanan, only in not being tufted.

DANTHONIA CRASSIUSCULA, T. Kirk.—Mount Arnould, Hunter River (5,000ft.).

DESCHAMPSIA PUSILLA, Petrie.—Hector Mountains (6,000ft.).

DESCHAMPSIA TENELLA, Petrie.—Sources of Water of Leith; Catlin's; Clinton Saddle. In all these stations only in bush.

DESCHAMPSIA CHAPMANI, Petrie.—Head of Clinton Valley, Te Anau (2,000ft.).

DESCHAMPSIA NOVÆ-ZEALANDIÆ, Petrie.—Naseby; Pembroke; Mount St. Bathan's; Hector Mountains. Ranges from 1,000ft.-4,000ft. Confined to very wet stations.

DESCHAMPSIA CÆSPITOSA, Beauv.—Common throughout in wet and boggy ground. Dunedin; Waihola; Waipahi; Lumsden; Roxburgh; &c.

KŒLERIA CRISTATA, Persoon.—Common in dry uplands and mountains, and on sandhills of E. coast. Dunedin; Old Man Range; Cromwell; Arrowtown; &c.

TRISETUM ANTARCTICUM, Trinius.—Not uncommon in rather dry stations. Dunedin; Maungatua; Mount St. Bathan's; &c. A variable plant.

TRISETUM SUBSPICATUM, Beauv.—Common, at 4,000ft. and upwards, on mountains of N., C., and W. Kurow Mountains; Old Man Range; Mount Pisa; Mount Cardrona; &c.

TRISETUM YOUNGII, Hook. f.—Not uncommon on mountains of W., at 3,500ft.-5,000ft. Carrick Range; Mount Bonpland; Mount Tyndall; Clinton Saddle; &c.

GLYCERIA STRICTA, Hook. f.—Common close to the sea on the E. and S. coasts. Oamaru; Dunedin; Catlin's; Bluff; &c.

ATROPIS PUMILA, Kirk.—Common on the mountains of the C. and N. and the higher lowlands of the E. and S. Macrae's; Waiwera River; Waipori; Blue Mountains; Mount Ida; Carrick Range; &c. Descends to 200ft. in the S., and reaches 4,000ft. in C.

ERAGROSTIS IMBECILLA, Hook. f.—Abundant in the drier parts of the E., C., and N. Dunedin; Manuherikia Valley; Maniototo Plain; Lake District; &c.

ERAGROSTIS BREVIGLUMIS, Hook. f.—Port Moeraki; Waipahi; Catlin's. Now a very rare grass, as it is greedily eaten by stock. It grows only in rich alluvial or volcanic lands, and is well worthy of cultivation, as it is a tender, succulent grass, yielding a large amount of herbage.

POA FOLIOSA, Hook. f.—Not uncommon on wet slopes on the mountains of the N., C., and W., at 3,000ft.-5,000ft. Mount Ida; Mount Pisa; Mount Cardrona; Clinton Saddle and Valley, where it descends to 1,500ft.

POA EXIGUA, Hook. f.—Old Man Range; Hector Mountains; Mount Pisa; Mount Cardrona; &c. (4,000ft.-6,000ft.).

POA CÆSPITOSA, Forst.—Common and often abundant in the drier lowlands of the E. and S.; more rare, and chiefly in sandy stations, in the interior.

POA COLENSOI, Hook. f.—Common throughout, and ranging from near sea-level to 6,000ft. Very abundant on the mountains of the C. and N. A most valuable fodder-grass, and very variable.

POA LINDSAYI, Hook. f.—Common in dry lowland stations in the C. and N. Waitahi Valley; Ngapara; Maniototo Plain; Tuapeka Mouth; Lake District; &c. Ascends to 3,000ft. at Mount Kyeburn.

POA SCLEROPHYLLA, Berggren.—On dry, broken shingle on mountains of C. and N.E. Mount Ida; Mount St. Bathan's (4,000ft.-6,000ft.).

POA PUSILLA, Berggren.—Common in the E. and S.; rarer in the interior. Dunedin; Maungatua; Catlin's; Kyeburn Crossing; Cambrian; &c. Ascends to 2,500ft. Dr. Berggren's figure of this plant represents a small depauperated form of the species.

POA INTERMEDIA, Buchanan.—Dry rocky stations in the C. Black's; Hamilton's; &c. I doubt if this is distinct from *P. colensoi*, Hook. f., which is a very variable plant.

POA PYGMÆA, Buchanan.—Plateau on top of Mount Pisa (6,000ft.).

POA KIRKII, Buchanan.—Not uncommon in mountain valleys and on mountain slopes in the E., C., and W. Maungatua (2,500ft.); Rock and Pillar Range; Hector Mountains; Humboldt Mountains. A variable plant.

POA MANIOTOTO, Petrie.—Common on dry salty plains and river-terraces of the centre. Kurow; Bendigo; Mount Pisa; Maniototo Plain (1,200ft.–3,000ft.).

POA COLLINSII, Kirk (MS.).—Nevis Valley; Nenthorn. This may be a form of *Poa kirkii*.

SCHEDONORUS LITTORALIS, R. Br., var. TRITICOIDES, Benth.—Common on sandhills of E. and S. coasts.

FESTUCA SCOPARIA, Hook. f.—Common on cliffs of the E. and S. coasts. Brighton; Catlin's; Stewart Island. I have not observed this north of Brighton, where it is abundant on spray-washed cliffs.

FESTUCA DURIUSCULA, L.—Most abundant at 1,000ft. and upwards, both on the dry plains and on the hills and mountains of the interior. West Taieri; Hyde; Maniototo Plain; Macrae's; Tarras; Hawea Flat; &c. This species has been confounded by some botanical workers and most settlers with *Poa cæspitosa*, Forst. It is a much more valuable grass than the latter, which is eaten only when very young. Together with *Agropyrum scabrum* and *Poa colensoi*, it forms the main sustenance of the great flocks of sheep depastured on the uplands of the South Island. It can be readily distinguished from *Poa cæspitosa* by the somewhat rough culm. The culm of the latter is always perfectly smooth.

AGROPYRUM SCABRUM, Br.—Common throughout the district, and especially in the dry terrace plains and lower mountain slopes of the central district. Dunedin; Clyde; Ida Valley; &c. The most nutritious grass in the colony, and one of the most difficult to eat out. Being greedily eaten by stock as well as by rabbits, it is seldom allowed to flower, but it holds the ground well in spite of this.

Asprella gracilis, Hook. f.—Not rare in alluvial flats and in the lower valleys of the E., C., and N. Dunedin; Eweburn Creek; Waipori; &c.

Asprella lævis, Petrie.—Catlin's; Matukituki Valley.

Triodia exigua, Kirk.—Not uncommon in dry plains and river terraces of C. and N.W. Kyeburn Crossing; St. Bathan's; Moa Flat; Lake Hawea. Ranges from 300ft.–2,500ft.

Triodia australis, Petrie.—Clark's Diggings; Mount Cardrona; Hector Mountains; Old Man Range; Blue Mountains; Maungatua (3,000ft.–5,000ft.). A useful fodder-grass, most abundant and very closely cropped on the Blue Mountains. Elsewhere it grows chiefly by the sides of shallow gently-sloping mountain brooks.

Besides the foregoing grasses I have from Waikouaiti and Deep Stream immature specimens of a grass that will no doubt prove a new genus. Mr. T. Kirk, F.L.S., has gathered the same plant in the Wellington District. I sent specimens of it to Kew a number of years ago.

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## Appendix.

*List of Plants reported from Otago which I have not gathered or observed.*

Ranunculus tenuis, *Buchanan.*
Pachycladon glabra, *Buchanan.*
Pachycladon elongata, *Buchanan.*
Lepidium australe, *Kirk.*
Notothlaspi hookeri, *Buchanan.*
Hectorella elongata, *Buchanan.*
Aristotelia erecta, *Buchanan.*
Melicope parvula, *Buchanan.*
Geum alpinum, *Buchanan.*
Gunnera hamiltoni, *Kirk.*
Ligusticum acutifolium, *Kirk.*
Olearia oleifolia, *Kirk.*
Olearia traillii, *Kirk.*
Erigeron novæ-zealandiæ, *Buchanan.*
Erigeron bonplandi, *Buchanan.*
Celmisia martini, *Buchanan.*
Celmisia robusta, *Buchanan.*
Abrotanella muscosa, *Kirk.*
Haastia montana, *Buchanan.*
Senecio buchanani, *Armstrong.*
Senecio stewartiæ, *Armstrong.*
Senecio bifistulosus, *Hook. f.*

Dracophyllum pearsoni, *Kirk.*
Mitrasacme hookeri, *Buchanan.*
Mitrasacme cheesemanii, *Buchanan.*
Logania armstrongii, *Buchanan.*
Gentiana hookeri, *Armstrong.*
Veronica glauco-cœrulea, *Armstrong.*
Veronica monticola, *Armstrong.*
Veronica tetrasticha, *Hook. f.*
Veronica carnea, *Armstrong.*
Veronica muelleri, *Armstrong.*
Pygmæa thomsoni, *Buchanan.*
Ourisia montana, *Buchanan.*
Plantago hamiltoni, *Kirk.*
Fagus blairii, *Kirk.*
Scirpus muscosus, *Kirk.*
Danthonia flaccida, *Kirk.*
Poa walkeri, *Kirk.*

## ART. LVIII.—*Phænogams: A Description of a few more Newly-discovered Indigenous Plants; being a Further Contribution towards the making known the Botany of New Zealand.*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 21st October, 1895.*]

### Class I. DICOTYLEDONS.

### Order I. RANUNCULACEÆ.

### Genus 3.* **Ranunculus**, Linn.

1. *R. rufus*, sp. nov.

Plant perennial, large, stout, everywhere hairy; hairs long, shaggy, flattish, acute, dull-red. Leaves broadly orbicular, 3¼in. long, 5in. wide, reddish-green, chartaceous; margins crenate, teeth broad rounded, base truncate and cordate, hairs strigosely situated; strongly primary-veined from petiole to margins, with secondary veins forming large areolæ of irregular shapes and sizes, usually 5–6 sided, with free branched veinlets within them (compound anastomosing); hairs forming a thickened elevated margin to leaves; petioles stout,

* The numbers of the orders and genera given here are those of them in the "Handbook of the New Zealand Flora."

4in. long. Flowering-stem 15in. high (perhaps more, specimens not having basal extremity), erect, very stout, ½in. diameter, naked; 9in. to first cauline leaf, thence 2–3 stout bibracteate stems, sub 4in. long; bracts 1¾in. long, narrow, sessile, and clasping; each stem bearing 3–5 flowers, on pedicels 2in. long, also bibracteate; bracts long, narrow, alternate, sometimes opposite; the lower and main cauline leaf large, orbicular (deeply trifid in one specimen), 2½in. diameter; petiole short, broad, and stout; hairs retrorse. Flowers large, spreading, forming sub-corymbs, 12–14 and more on one scape. Sepals 4, elliptic, ½in. long, thin, margins very membranous, longitudinally hairy along middle on outside, and very hairy and ciliate at tips. Corolla, petals 4, broadly cuneate, ¾in. long, ½in. wide at top, tips flat-rounded, bright-yellow, shining, veined; base of petals narrow, thickened; nectary small, close to base, foveolate, with a semicircular ridge below; the 3 primary veins from base largely dichotomous, and running subparallel to tip. Stamens very numerous, ¼in. long, flat, 1-nerved; anthers 1 line long, narrow, elliptic, with membranous margins. Carpels many, closely packed, forming ovoid heads (immature), ½in. long, hairy, with long hairy tails, their upper portion having a flattish submembranous margin, tips acute, glabrous.

*Hab.* Ruahine Mountain-range, east side: *Mr. H. Hill*, 1894; *Mr. E. W. Andrews*, 1895.

*Obs.* This fine plant has close affinity with three other known species from the same alpine locality—viz., *R. insignis*, Hook.; *R. ruahinicus*, Col. (Trans. N.Z. Inst., vol. xviii., p. 256); and *R. sychnopetala*, Col. (Trans. N.Z. Inst., vol. xxiii., p. 324, and vol. xxvi., p. 313)—but differing from them all in several characters, and particularly in its peculiar and striking shaggy carpels.

## Order VII. Portulaceæ.

### Genus 1. **Claytonia**, Linn.

1. *C. calycina*, sp. nov.

A small perennial low creeping herb, subsucculent, glabrous, rooting at nodes. Stems stout (for plant), branchlets short, about ¼in. apart on main stem. Leaves linear, ¾in. long, ½ line wide, tips obtuse, thickish, in fascicles of 4–5, stipulate. Flowers terminal on branchlets, 2–3 together; pedicels of various lengths, ¾in.–1in. long. Calyx 2 large persistent broad sepals, half as long as corolla, concave, much imbricate in bud and in flower, tips rounded. Corolla white, 4 lines diameter, lobes obovate, obtuse, incurved, veined. Stamens white, spreading; anthers oblong, red; style half as long as stamens; stigmas 2, erect, linear, acuminate, pointed, minutely pubescent.

*Hab.* Ruahine Mountain-range: *Mr. A. Olsen;* 1895.

*Obs.* This species is near the only other known southern one (*C. australasica*), but differs in its scape being 2–3 flowered, in its very much larger calyx (a striking character), different-shaped anthers, and bifid instead of trifid stigma. Of *C. australasica* Hooker says, in first describing it ("Icones Plantarum," tab. 293), "petalis calycem quadruplo superantibus"—which his plate, with dissections, clearly show; and Bentham, "sepals small orbicular, petals several times longer; style 3-cleft," &c. ("Fl. Australiensis," vol. i., p. 177).

## Order XXVI. DROSERACÆ.

### Genus 1. **Drosera**, Linn.

1. *D. ruahinensis*, sp. nov.

Plant perennial, tufted, erect, sub 2in. high, glabrous; rootstock long and straight, woody, much fibrously branched; the whole plant very dark coloured (blackish) when dry. Leaves with petioles 1¾in. long, of two forms, ovate-acuminate, and broadly orbicular-spathulate, lamina of the latter very glandular on upper surface; glands long, flat, flexuous, and straight, dark-red, broadest at base, tips subobovoid; petioles sub 1¼in. long, broad, membranous, veined, half-clasping. Scape ¼in.–½in. longer than leaves, filiform, naked. Flower solitary, small, 3 lines long; calyx lobes broadly-elliptic-oblong, tips slightly jagged. Corolla a little longer than calyx; petals membranous, suborbicular, entire, whitish tinged with rose-colour, veined. Stamens flat, broad, shorter than calyx, included; anthers cordate, yellow. Styles 3, short, stout; stigmas capitate, large, papillose; ovary sub-ellipsoid-globular.

*Hab.* Ruahine Mountain-range: *Mr. H. Hill*, 1895; *Mr. A. Olsen*, 1895.

*Obs.* A species having affinity with *D. arcturi*, Hook., and *D. polyneura*, Col. (Trans. N.Z. Inst., vol. xxii., p. 460), but differing from both in several grave characters.

2. *D. stylosa*, sp. nov.

Plant slender, weak, suberect; stem 10in.–12in. high, dark-green, almost black (so also stem-leaves and -sepals), striate, slightly branched, 1–2 small branches near top, each bearing 2–3 leaves and a single terminal flower. Leaves rosulate, 9–10, broadly orbicular, 2 lines wide, glandular on upper surface and at margins (glands in centre of lamina very short and small), glabrous below, pale yellow-brown; petioles flat, stout, ½in. long. Stem-leaves broadly lunate and peltate, 2 lines wide, much glandular on upper surface; glands flattish, long (irregular lengths), strong, spreading, those of the two

angles very long, stout, and branched (three leaves together erect at base), scattered alternately throughout stem, 6–8 lines apart, the lower solitary, afterwards 2 together, then 3–4 subfascicled; petioles filiform, 7–8 lines long. Raceme at top 1½in.–2in. long, with a few (5–7) distant flowers, having a single small linear toothed acuminate adpressed bract between them; pedicels finely filiform, 2–3 lines long. Sepals broadly oblong, 2 lines long, membranaceous, veined, glabrous, roughish, minutely tuberculate; tips much jagged. Corolla very membranous, twice length of sepals; petals broadly cuneate, pink, veined; styles 3, stout, spreading, much branched at top; branches flattish, with numerous minute terminal and marginal globular dots. Anthers very small, suborbicular, white; stamens dark-coloured. Ovary elliptic-globose, dark-green. Seeds linear, acuminate, somewhat falcate, brownish.

*Hab.* Ruahine Mountain-range, east side: *Mr. H. Hill;* 1895.

*Obs.* A species very near to *D. auriculata*, Backhouse, but differing in its branched stem (in number and position of stem-leaves), in bracteolate raceme, in broad laciniate sepals, and in its very peculiar styles, these last being a most interesting and curious object under the microscope.

## Order XXXVIII. Rubiaceæ.

### Genus 1. **Coprosma**, Forst.

1. *C. margarita*, sp. nov.

A small low shrub; bark dark-coloured, purplish; branches very slender, erect, and drooping when in fruit (specimens 6in.–8in. long); branchlets numerous, rather close, opposite, short, filiform, somewhat angular, thickly clothed with short greyish hairs, strigosely pubescent. Leaves few, more numerous at tips of branchlets, linear, 9 lines long, $\frac{1}{16}$in. wide, glabrous, green, acute and subacute, slightly falcate, recurved, tips callous, tapering at base; petioles very short, purple. Stipules small, deltoid-acuminate, acute, pilose, ciliolate. Flowers: *male* not seen; *female* solitary, terminal on very short branchlets and often opposite, sometimes having a pair of linear leaf-like bracteoles at base, purple-margined, their tips minutely ciliolate, as also are the teeth of the calyx, which are very small; peduncles slender, wiry, 1 line long. Corolla small, infundibuliform, ¼in. long, pale-yellow irregularly spotted with purple, 4-lobed; lobes subovate and subacute, spreading, margins purple; styles twice as long as tube, stout, very pubescent, obtuse, spreading. Fruits numerous, globular, $\frac{1}{10}$in. diameter, white, shining, semitransparent, crowned with the minute calycine lobes. Seeds 2, suborbicular, plano-convex, $\frac{1}{16}$in. diameter, whitish.

*Hab.* Ruahine Mountain-range, east side: *Mr. A. Olsen;* 1895.

*Obs.* A very distinct species of this rather difficult genus, and very handsome when in fruit; its little solitary, globose, white, shining fruits resembling pearls strung on its light feathery foliage (whence its specific name). At this season its appearance is most striking, further increased by the graceful drooping of its slender loaded branches. I regret not having seen its male flowers; indeed, my female specimens—in fruit and in early flower—are the result of two visits made during two seasons, autumn and spring, to the mountains.

Genus 2. **Nertera**, Banks and Solander.

1. *N. montana*, sp. nov.

A small low creeping succulent glabrous herb, rooting at nodes, 1in.–3in. high, branches numerous and very short. Leaves suborbicular, broader than long, apiculate, 1–2 lines diameter, concave, tapering, a few rather long weak white ciliæ at margins; these are flat, semitransparent, and jointed; petioles 1 line long. Flowers small, terminal on short branchlets, sessile, pale-greenish. Corolla, tube shorter than limb; lobes deltoid, subacute, spreading, subhyaline, pubescent within. Stamens spreading longer than styles; anthers exserted, suborbicular and cordate, yellow; styles 2, spreading, recurved. Ovary broadly ovoid, glabrous.

*Hab.* Ruahine Mountain-range, east side: *Mr. A. Olsen;* January, 1895.

2. *N. papillosa*, sp. nov.

A minute low creeping herb, 3in.–4in. long, rooting at nodes, much branched; branches very short; subsucculent, glabrous, finely papillose; stems purple-splashed. Leaves very small, scarcely 1¼ lines long, suborbicular-deltoid, tip subacute, pale-green with purple margins, stippled below; petioles as long as leaves. Flowers terminal, very small, sessile; corolla 1 line in diameter, greenish-yellow, 4-parted; lobes deltoid, acute, finely pubescent within; stamens 4, longer than lobes; anthers orbicular, yellow; stigmas 2, recurved, shorter than anthers; ovary oblong. Fruit globular, glabrous, shining, sessile, $\frac{1}{10}$in. diameter, red. Seeds 2, oblong-ovoid, $\frac{1}{20}$in. long, plano-convex, greyish-white.

*Hab.* Low wet spots on the sides of the mountain Tongariro, in the Taupo district: *Mr. H. Hill;* 1893.

*Obs.* This is an interesting little plant—a perfect gem—in its lustrous, lowly, humble beauty. I have succeeded in growing it, and therefore have been able to watch its minute development, and to note all its grave characters in its fresh

state, in confirmation of dried specimens brought away by Mr. Hill.

## Order XXXIX. Compositæ.

### Genus I. **Olearia**, Mœnch.

1. *O. consimilis*, sp. nov.

A bushy shrub, 5ft.–6ft. high, with long slender branches; bark dark-brown, striate. Branches numerous, erect, straight and drooping, opposite, angled, ribbed; bark reddish-brown, bright, shining on the younger branchlets, with more or less of orange-coloured dry waxy exudation, which is also scattered on leaves (beneath), and peduncles. Leaves numerous, regularly distant on branchlets, 6–9 lines apart, fascicled, 5–7 together on the lower and 3 on the upper part of branchlets, opposite, but on flowering branchlets the terminal portion above the flowers has only single leaves opposite, erect, spreading, linear or sub-linear-spathulate, 2 lines long, $\frac{1}{10}$in. wide, thickish, tip broadly rounded, base slightly tapering, sessile, margins entire subrevolute, dark-green and slightly scaberulous above with midrib deeply sunk, the same slightly prominent and orange-coloured below, with close whitish shining hairs. Heads many, solitary, axillary, regularly opposite (in pairs) on lateral branchlets, 2–3 lines apart, subcampanulate, 4 lines long, 1½ lines diameter; peduncles 1 line long. Involucral scales many, imbricate in 4 rows, yellow, shining, with a green central stripe in their apical portion, the outer broadly ovate and short, the middle narrow ovate acuminate, the innermost longest 2½ lines long, very narrow linear-lanceolate, with thin undulating shining margins, coarsely ciliate-jagged. Florets few (11), as long as pappus, slender, red-brown (dry); style-arms very long recurved brown roughish lanceolate, tips acuminate, acute. Pappus nearly equal, white, shining, slightly scabrid, tips acute. Achene linear, flattish, striate, glabrous, shining.

*Hab.* Norsewood, County of Waipawa—margins of woods and streamlets: *Mr. A. Olsen;* 1895. (Flowering in autumn.)

*Obs.* A species very near to *O. fasciculata*, Col. (Trans. N.Z. Inst., vol. xxv., p. 330), but differing from that species in fewer rows of involucral scales, of a different colour, and free from waxy exudations, &c.

2. *O. quinquefida*, sp. nov.

A shrub "7ft.–8ft. high," of upright growth; branches long, slender; bark darkish-brown, striate, with minute whitish membranaceous scurf; branchlets very slender and straight, erect, bark red-brown, glabrous, shining, with slightly scattered red scaly exudation, angled, a prominent ridge decurrent from base of pair of leaves above to the next pair below. Leaves

numerous, decussate, sub-linear-spathulate, 2–2½ lines long, scarcely ½ line broad, erect, opposite and sub-fascicled 3-4-5 together, the bases of the outer pair semiclasping and meeting around the stem, margins entire, revolute, green glabrous and slightly scurfy above, densely hairy below; hairs whitish-grey, coarse and dull; petioles short, stout, those of the outermost pair of leaves thickened at bases. Flowers numerous, heads narrow, campanulate, 2 lines long, solitary, sometimes 2 (rarely 3) together, opposite, 4–6 lines apart on branch, regular and extending nearly throughout long branches, and on very short lateral branchlets, axillary, sessile, surrounded by leaves. Involucral scales in 7–8 rows, broadly ovate-obtuse, closely imbricate, bright-yellow, glabrous, their centres pale with closely appressed hairs, and a line at apex, the outermost very small increasing in size upwards, the innermost 2–2½ lines long, thin, brownish and shining within and largely reverted at maturity, their margins rumpled and slightly jagged. Florets very few, slender, as long as pappus; *disk*, lamina deeply cut into 4–5 linear lobes, their margins thickened and dark-coloured, tips acute hairy; style longer than corolla, arms filiform very long, rough, jagged, tips obtuse but not truncate; *ray*, lamina very narrow, revolute, 3-nerved, tip 3-toothed; style-arms shorter than lamina. Pappus numerous, patent, spreading, slightly scaberulous, tips acute, whitish with a pale reddish-brown hue. Achenes small, glabrous, pale, subangular, slightly striate, thickened at top.

*Hab.* Hilly country near Lake Tutira, County of Wairoa, Hawke's Bay: *Mr. Guthrie-Smith*; 1895.

*Obs.* A species much resembling and having close affinity with the preceding one, *O. consimilis*, but differing in involucral scales; in the many-lobed lamina of its disk-florets, with their peculiar-coloured margins; in its very long style-arms; and in its spreading, reverted, shining, brown involucres after flowering, that give it a curious appearance.

3. *O. aggregata*, sp. nov.

A thickly-branched shrub, 5ft.–6ft. high; branchlets 1ft. or more long, very slender, simple, rarely forked, subangular; bark dark-red-brown, glabrous, much coarsely striate. Leaves few, distant, opposite, fascicled 6–8 together, forming very small lateral branchlets, oblong-lanceolate, 3–5 lines long, 1¼ lines wide, not thick, petiolate, margins entire and slightly recurved; tips subacute, dark-green and glabrous above, densely pubescent below; hairs appressed, white shining with a reddish tint, flat, lanceolate, acute, centrally fixed; midrib showing full-length beneath, its hairs also being darker; petiole 1 line long, hairy; hairs reddish, glossy, and so the

young leaves. Flowers numerous, opposite, fascicled: (1) On main branches regularly distant, ¾in. apart, and terminal on very short lateral branchlets (or spurs), 4–6 together among leaves; (2) on branchlets much closer, 4–5-fascicled, covering branchlets. Heads small, campanulate, ¼in. long; peduncle 1 line long, hairy, bibracteate. Involucral scales oblong, very hairy especially on margins and tips, few in 3 rows, the outer smallest, middle broadest with a dark central line, inner longest and narrowest and more membranous. Florets few; of *ray* 6, lamina 4-nerved, tip truncate, 3-toothed; style very short, as long as tube, arms short, obtuse; of *disk* 5, tips of their lobes ciliolate. Pappus few, erect, white, much shorter than florets, densely scabrid, tips subacute. Achene small linear angular thickened upwards, dull-brown, glabrous.

*Hab.* In the Weber district, County of Patangata, between Dannevirke and the East Coast: *Mr. H. Hill;* November, 1895.

*Obs.* A truly handsome shrub, from the great regularity of its numerous and neat symmetrical heads of flowers in small knots or bunches on its slender branches. This species belongs naturally to the same sub-section as the two former ones, but is very distinct.

4. *O. parvifolia*, sp. nov.

A small bushy shrub of diffuse growth, 6ft.–8ft. high, with erect twiggy branches; branchlets slender, glabrous, angular, dark-red, striate. Leaves and flowers produced together in small knots or bunches, 5–7 lines apart, opposite; leaves few, 3–4–6 together fascicled, very small, 1½–2½ lines long, subobovate tapering to base, tip obtuse and rounded, glabrous and dark-green above (sometimes hairy, hairs substrigose adpressed), densely pubescent below, hairs white (reddish in young leaves), shining, short, appressed; midrib lower half prominent underneath; petiole 1–1½ lines long. Heads 3–5 together (sometimes solitary), narrow campanulate, sub 2½ lines long, patent, spreading, axillary among leaves; peduncles slender, 2 lines long, hairy. Involucral scales hairy, in three rows; the *outer* 2–3–5 thickish, ovate, short, bract-like, dark-coloured (may be termed bracts, but they adjoin the other scales proper, and close round the head with them); the *inner* thin, green, shining, sub-linear-lanceolate, concave; tips acute and thickly woolly-ciliolate. Florets few, of disk and of ray equal in number, usually 4 of each, sometimes 5; *ray*, lamina small narrow pale-brown, tube slightly hairy, style two-thirds length of lamina, arms spreading, acuminate subacute; *disk* florets longest, much exserted, dark-brown, tube hairy, tips of lobes pubescent, anthers largely exserted

their tips very acuminate pungent, pale; stigmas large, rough, bristly, dark-red, tips acute. Pappus few, white, erect, scaberulous, shorter than disk-florets. Achene small linear terete, thickest at top, glabrous.

*Hab.* In low damp grounds, and on margins of water-courses, South Norsewood, County of Waipawa: *Mr. A. Olsen*; 1894–95. (Also, in former years, but barren: *W. C.*)

*Obs.* A species near to *O. virgata*, Hook.

### Genus 17. **Senecio**, Linn.

1. *S. rufiglandulosis*, sp. nov.

Annual. Herb stout, erect, simple, glabrous, 2ft.–3ft. high; stem thick, ¼in. diameter, subangular, hard below but not woody. Leaves few, distant 1in.–2in. apart on stem, ovate acuminate acute, irregularly and coarsely duplicato-dentate, lamina 4in. long, 2¼in. wide, tapering to base and there largely dilated ½in. or more, cordate auricled but free from stem not clasping, soft, very thin, margins thickened and recurved (very plain in young leaves), light-green above, much paler below, glandular-pubescent; pubescence above suberect and curled, scattered, small, their tips darkish-red, smaller and shorter below; veins few, distant, 6-jugate; midrib stout, prominent underneath throughout lower half of leaf; petiole 2in. long, succulent, stout, channelled, white, 3 lines wide, winged; wings denticulate. Flowers in a large loose many-branched diffuse corymbose panicle, 8in.–10in. diameter; main flowering-branches 10in.–12in. long, axillary, erect, slender, striate, terete, yellow-green, without leaves, but having a long narrow leaf-like bracteole at base of peduncle, each branch containing 5 heads, with a long linear toothed bract at base of lowest branchlet; pedicels slender, 6–9 lines long, with a subulate bract at base and another on pedicel. Heads campanulate, 3 lines long. Involucral scales many in a single row, oblong-acuminate, green, glandular, slightly viscid, margins broad white membranous greatly imbricate, tips hairy acute tipped with black, 4–5 narrow subulate bracteoles also tipped with black at base, spreading, clasping head. Flowers expanded ¾in. wide, light-yellow; florets of *ray* 12, lamina narrow-oblong-lanceolate spreading and subrevolute, tip rounded 3-toothed, the central tooth obtuse and lower than the two outside ones; style arms small, slightly exserted from tube—of *disk* numerous (sub 40), 5-toothed; styles exserted short, linear truncate, much recurved. Pappus white, erect, a little longer than involucre, shorter than disk-florets, scabrid, acute. Achene linear semi-terete, densely pubescent, striate, slightly thickened upwards, base obtuse, alveolar. Receptacle rugged.

*Hab.* East sides of Ruahine Mountain-range, about 3,000ft.–4,000ft. altitude, on margins of watercourses, and also on dry stony spots: *Mr. A. Olsen;* 1894–95.

*Obs.* This fine herb has some affinity with *S. glastifolius*, Hook. fil.

## Order XLII. Ericeæ.

### Genus 1. **Gaultheria**, Linn.

1. *G. glandulosa*, sp. nov.

Shrub glabrous (specimens 5in. long, terminating in 3–6 branchlets, each 2in. long, and nearly alike); bark pale, muricated with small red and black callous points, the young branchlets having a single long black flat hair-like scale, acuminate and strigose, appressed upwards from each dot. Leaves numerous, alternate, close, imbricate, flat, erect, lanceolate-oblong, 8 lines long, 2 lines broad, subapiculate, closely serrate; teeth apiculate with black callous points; tapering at base; petiolate; reddish-green; closely and regularly reticulated on both sides, minutely rugulose above with a kind of varnished appearance; petioles sub 1 line long, stout, red. Flowers very numerous, terminal in corymbose panicles, very close-set, small, reddish (dried). Calycine lobes broadly ovate, spreading, concave, margins glandular ciliolate; peduncles slightly pilose, much bracteate; pedicels glabrous, 1 line long, with 3 sessile bracts at base, clasping, broadly deltoid-ovate, apiculate, margins glandular-ciliolate or serrate (*sub lens*). Corolla broadly campanulate, veined; tube $\frac{1}{10}$in. long; lobes broadly deltoid, very obtuse, much recurved, margin of tips irregularly and minutely jagged. Stamens short, as long as anthers, warted, broadest at extreme base; anthers small, simply horned, minutely muricatulate, base rounded, dark-red. Style as long as tube, slightly exserted; stigma simple. Hypogenous scales longer than ovary, their tips rounded.

*Hab.* Ruahine Mountain-range, east side: *Mr. H. Hill*, 1894; *Mr. E. W. Andrews*, 1895.

*Obs.* A truly handsome and neat species, differing considerably from all known ones, yet having close affinity with *G. subcorymbosa*, Col. (Trans. N.Z. Inst., vol. xxii., p. 476).

### Genus 3. **Cyathodes**, Br.

1. *C. articulata*, sp. nov.

A (small?) glabrous shrub; branch (specimen) 4in. long, slender, woody, bearing several very short branchlets 1in. long, bark greyish. Leaves suberect, close, decussate, imbricate, linear acuminate a little broader at base, 3½ lines long sub ½ line wide tapering into a long callous acute tip, thickish,

margins recurved entire; pale-dull-green above and somewhat glossy; paler below and 4-nerved, nerves white; petiole short, stout, broad, flattish, articulated to a little circular knob in the branchlet. Flowers terminal on the branchlets, 5–7 together forming small heads, pale-reddish or fawn colour; peduncles short, bearing small suborbicular bracts; calycine lobes or bracteoles larger, broadly ovate obtuse, pinkish, margins thin, minutely ciliolate at tips; corolla tubular sub 3 lines long veined; lobes 5, small ovate acute, glabrous not bearded; tube slightly hairy within; anthers adnate opposite angles of lobes, slightly exserted, linear, emarginate both ends, dark-brown; style erect, nearly as long as tube, slightly hairy below; stigma simple; ovary densely hairy; hairs appressed, pure white. Hypogenous scales, small, orbicular.

*Hab.* Hills in the interior, west of Napier; 1895.

*Obs.* I. Of this plant I received only a solitary specimen (among those of other plants), apparently casually gathered in passing as of no great consequence; all the little branchlets on it were very similar and perfect.

II. I place it here under *Cyathodes* (not having seen its fruit) mainly owing to the lobes of the corolla being glabrous and the leaves so very pungent. A curious feature is the knobbed articulations of its branchlets for its leaves.

Genus 5. **Pentachondra,** Br.

1. *P. rubra*, sp. nov.

A low shrub 3in.–4in. high, ascending, erect, much branched; branchlets short, 1in.–2in. long, bracteate; bracts numerous, imbricate, sessile, red-brown, ovate, obtuse, striate, small at base of branchlets increasing in size upwards, 1 line long at top. Leaves close-set, erect, narrow ovate (the uppermost linear-ovate), $\frac{1}{4}$in. long, $\frac{1}{16}$in. broad, obtuse, tips callous, glabrous, concave, margins finely ciliolate, 3-5 nerved below, pale-dull-green; petiolate, petioles $\frac{1}{2}$ line long, red, striate, stout, flattish. Flowers few, solitary, terminal, red; tube cylindrical, 3 lines long, glabrous and shining on outside, slightly hairy within; lobes 5, sub 1 line long, narrow linear-ovate subacute, recurved, spreading, densely bearded, hairs red; bracteoles broadly ovate, obtuse, much ciliate. Anthers linear, subclavate, widest at top, subacute at base; style erect, stigma capitate. Disk-scales, tips truncate. Fruit obovate, $\frac{1}{4}$in. long, red, style persistent. Nuts 8, subreniform, gibbous, red, muricatulate-rugose.

*Hab.* Ruahine Mountain-range: *Mr. E. W. Andrews;* 1895.

*Obs.* This plant, having 8 pyrenes in its fruit, does not agree with its generic name, nor with Bentham's statement respecting the genus—viz., "with 5 distinct pyrenes, or *fewer*

by abortion" (Fl. Austral., vol. iv., p. 163). Yet Hooker says of it, "Drupe of 5 or *more* small 1-seeded nuts" (Handbook N.Z. Fl., p. 178). In other respects it agrees with the genus, and it may, with the next plant hereunder described, serve to unite those two nearly-allied genera.

### Genus* **Trochocarpa**, Br.

1. *T. novæ-zealandiæ*, sp. nov.

A low bushy shrub, 1½in.–2in. high, much branched, glabrous; branches short; stems woody, slender, blackish. Leaves numerous, close, imbricate and spreading, lanceolate, 1¼ lines long, ½ line wide, tip subacute-obtuse, 3–5-nerved below, rather thickish, margins entire; dark-purplish-green; petioles rather stout, ½ line long, red; margins of young leaves toward apex minutely ciliolate (*sub lens*). Flowers few, solitary, terminal and axillary on tips of branchlets, sessile. Sepals 5, ovate-acuminate, tips obtuse, margins finely ciliolate; 2 broad bracteoles below calyx, and smaller roundish ones outside. Corolla subcylindrical, 2 lines long, valvate in bud, tip acute, white with pink tips on outside; tube slightly hairy half-way down; lobes 5, equal, acute, much bearded within, and 2-nerved from base. Anthers linear-oblong, brown, adnate, close to angle-bases of lobes; style stout, erect; stigma capitate, papillose. Fruit red, globular, shining, 2 lines diameter, pulpy, style persistent. Seeds 9, yellow, oblong, plano-convex.

*Hab.* Summits Ruahine Mountain-range, east side: *Mr. A. Olsen*; January, 1895.

*Obs.* It is not without some doubt that I place this neat little plant under this endemic Australian genus. It has much of the common appearance (*primâ facie*) of a *Pentachondra*, but its fruit is strikingly different, also its pyrenes, and its corolla-lobes are not so densely bearded.

### Genus 8. **Dracophyllum**, Lab.

1. *D. pungens*, sp. nov.

A (small?) shrub (specimens 6in. long); branches straight, erect, very leafy, simple; bark dark-purple with thin silvery scurf epidermis; branchlets 3–4 near top, subopposite and subfascicled, very slender, 1in.–2in. long, $\frac{1}{30}$in. wide, erect, bearing 4–5 leaves at tips; bark red, glabrous, shining. Leaves erect, subrigid, filiform, 2½in.–2¾in. long, ½ line wide, thickish, concave above, semi-terete below, margins entire, tips pungent; colour pale-yellowish-green, fugacious in drying; sheaths large, 5 lines long, 2 lines wide, red, margins thin,

* An Australian genus, closely allied to the preceding, but not hitherto detected in New Zealand.

dilated rather suddenly but not truncate, minutely and sparingly ciliolate at apex extending a short distance on margins of lamina. Flowers terminal on main branch in a short stout raceme 1¼in. long, ½in. wide, 7–9 together, alternate, subdistichous, not crowded; bracteoles few, the outer one longer than corolla, inner shorter, broadly ovate-acuminate, their margins very membranous and finely ciliolate, bases enwrapping; pedicels short, stout, wrinkled. Sepals narrow-ovate-acuminate, very acute. Corolla red, campanulate, 4 lines long, mouth 2½ lines diameter, lobes large, deltoid acuminate acute, recurved. Anthers oblong-ovate, obtuse. Style 1 line long, capitate. Scales half as long as ovary, broadly cuneate, tips truncate.

*Hab.* On Ruahine Mountain-range, east side: *Mr. H. Hill;* 1895.

2. *D. varium*, sp. nov.

A shrub; ascending, erect (single specimen 6in. long, 6-branched at top); main stem stoutish, 1½ lines diameter (naked below for 2in.), bark greyish, much fissured longitudinally, ringed; branchlets slender, ringed regularly $\frac{1}{16}$in. apart, bark red-brown, shining with thin silvery epidermis. Leaves terminal, close, clasping and subimbricate at bases, patent and subrecurved, linear acuminate, 1¼in. long, 1 line wide at base of lamina, not coriaceous nor stout, slightly concave, nerved, margins faintly scaberulous below finely serrulate above, tips subacute, colour dull darkish-green; sheathing bases reddish, 1½ lines long, $\frac{1}{10}$in. broad, soon dilated but not truncate, 6-nerved, margins thin entire, very finely and shortly ciliolate on shoulders only. Flowers terminal in short stout spikes sub 1in. long, 8–10–12-flowered, very close together, almost hidden in bracteoles which are ovate-acuminate, as long as or longer than corolla, margins much ciliolate, tips acute. Sepals linear, acute, transversely wrinkled, red-brown. Corolla reddish, small, 1½ lines long, tubular; lobes erect, subovate-obtuse, their margins undulate. Anthers narrow-oblong, 2-lobed, adnate, nearer the mouth of tube than usual, so as to be partly on lobes at their bases. Style short, stout. Ovary small, grooved, narrowest at base; scales as long as ovary, broadly cuneate, their tops rounded, retuse.

*Hab.* On Ruahine Mountain-range: *Mr. H. Hill;* 1895.

3. *D. angustifolium*, sp. nov.

Shrub erect, much branched, fastigiate, slender (specimens 8in.–9in. long); bark dark-red, shining on young branches; branches numerous, subfascicled, very slender, almost filiform, $\frac{1}{24}$in. diameter, 5in.–7in. long, distantly and regularly scarred; secondary branchlets also long, simple, with many buds of

branchlets. Leaves numerous, imbricate and sheathing, close at tops of branches but distant along young branchlets, subulate, thickish, 3–9 lines long, $\frac{1}{20}$in. wide, tips obtuse with a callous mucro, margins minutely and finely serrulate (*sub lens*), concave above semiterete below; sheaths gradually dilated, 2 lines long, 5-nerved, their margins very thin, ciliolate on upper portion. Flowers few, 2–3 together, terminal on small stout lateral branchlets. Calyx sub-linear-lanceolate, $1\frac{1}{2}$ lines long, margins thin, ciliolate, tip mucronulate. Corolla red, longer than bracteoles, 2 lines long; lobes deltoid subacute erect, margins slightly uneven and incurved. Anthers orbicular. Style short, stout, ovary truncate at apex. Scales broadly cuneate, their tips truncate and slightly retuse.

*Hab.* Ruahine Mountain-range: *Mr. H. Hill*; 1895.

*Obs.* A species of a most peculiar aspect, from its very slender fastigiate branches, and excessively narrow and short erect leaves.

4. *D. brachyphyllum*, sp. nov.

A small low shrub (from specimens 4in.–5in. long, one of them being apparently gathered from base), ascending or suberect, much branched; branchlets fastigiate, short, suberect, 1in.–2in. long, slender, much scarred (or, more properly, ringed), regularly 1 line apart; bark red-brown, glabrous, shining. Leaves rather numerous, patent, recurved, linear subulate, thickish, 5–7 lines long, $\frac{1}{20}$in. wide, subquadrifariously disposed, concave, veined, margins finely serrulate, tips obtuse with a minute callous subacute mucro; colour dull-dark-green. Sheathing-bases largely clasping, 3 lines long, 2 lines wide, much veined; margins membranous, finely and minutely ciliolate above, gradually contracting into lamina. Flowers few, close-set, terminal on main branch in a short stout raceme sub 1in. long and bearing 7–9 flowers; bracteoles $\frac{1}{4}$in. long (as long as tube of corolla), deltoid acuminate, 2 lines broad at base, many veined, enwrapping, margins membranous and finely ciliate; tips thickened acute, callous; the outermost one a little longer than corolla with its tip dilated; pedicels stout, 1 line long, transversely wrinkled. Sepals narrow linear, very concave, margins ciliate. Corolla 3 lines long, cylindrical, red; lobes small, recurved. Anthers small, oblong, situated lower down in tube than usual. Style longer than ovary, stout; ovary small, sides grooved. Scales broadly cuneate, truncate, slightly retuse, higher than ovary and slightly incurving over it.

*Hab.* Ruahine Mountain-range: *Mr. H. Hill*; 1895.

*Obs.* A species near *D. recurvum*, but differing in several characters.

5. *D. virgatum*, sp. nov.

Shrub erect ("6ft. high"), bark greyish, much branched; branches virgate, 10in.–14in. long, slender, scarred, ringed 1–1½ lines apart; branchlets numerous, 3in.–5in. long, very slender, $\frac{1}{20}$in. diameter, erect. Leaves pale-green, filiform, 4½in.–5in. long, $\frac{1}{30}$in. wide, acute, channelled, margins minutely serrulate. Sheathing-bases ¼in. long, 2 lines wide, glabrous, reddish-brown, auricled, auricles acute, margins entire membranous. Flowers ("white sweet-scented") terminal in single racemes sub 1in. long, 7–8-flowered, on short lateral rather distant branchlets; flowers alternate, with 3 (sometimes 4) long leafy bracts at base of raceme; pedicels short, 1 line long, stout; bracteoles ovate-acuminate, concave, ciliolate, longer than tube, the outermost one largely awned, the inner ones pubescent above on middle of back. Sepals ovate-acuminate, nearly as long as corolla, pungent. Corolla small, dark-red, tube 1 line long, lobes spreading narrow ovate-acuminate; tips thickened, slightly incurved. Style stout, exserted, persistent. Stigma large, obsoletely 5-lobed, papillose, shining.

*Hab.* On Ruahine Mountain-range, east side: *Mr. A. Olsen*; 1895.

*Obs.* A very striking shrub of this genus; its very long and slender branches and leaves allies it with *D. squarrosum*, from which species, however, it is very distinct.

6. *D. heterophyllum*, sp. nov.

An erect (small?) shrub, my specimen a single branch 3in. long; slender, bark dark-purple, glabrous, ringed 1 line apart; branchlets opposite, 3, subfascicled, besides the main one, and 1in. above two others similar. Leaves rather numerous, of irregular lengths, linear, erect, nearly rigid, dull-pale-green, terminal—on main branch 4½in. long $\frac{1}{20}$in. wide, on lowermost branchlets 3in. long, and on two uppermost branchlets 1½in. long—and filiform, sub $\frac{1}{30}$in. wide, canaliculate above, semiterete and striate below, margins entire or very minutely scabrid (*sub lens*), tips acute. Sheathing-bases abruptly expanded, 1½–2 lines wide, half-clasping, red, the upper portion of margins minutely ciliolate. Flowers in short terminal spikes, ¾in. long, 6-flowered, alternate, sessile; calycine bracts (6) as long as tube of corolla, closely enclosing one another, the inner 4 very small and narrow, 1 line long, subulate, very acute, margins thin and ciliolate; the 7th or outermost bract broadly deltoid, 4 lines long, including the narrow subulate sharp callous tip, which is 2 lines long. Corolla tubular, 3 lines long, glabrous, red, 2 lines diameter at mouth; lobes spreading ovate, subacute, thin, veined. Anthers suborbicular, emarginate, and cordate. Style half as long as corolla. Stigma

capitate. Hypogenous scales oblong, longer than ovary, their tips rounded.

*Hab.* Ruahine Mountain-range, east side: *Mr. E. W. Andrews*; 1895.

## Order L. Boragineæ.

### Genus 1. **Myosotis**, Linn.

1. *M.* (*Exarrhena*) *venosa*, sp. nov.

(A single specimen, evidently taken from a rootstock.) Ascending and erect, simple unbranched, slender, strongly ribbed, 10in. high (including racemes not fully expanded), hairy; hairs long, patent, white, arising from muricated points. Leaves on stem few (6), alternate, distant ½in.–¾in. apart, oblong apiculate, 1¼in. long, ¼in. wide, strigosely hairy on both sides, ciliate, brown (so calyx), midrib prominent below, the lower 4 subpetiolate, lamina tapering to base; on top of stem a pair much smaller opposite and sessile, enclosing 2 racemes, one 4in. and one 2in. long, largely scorpioid, the shorter one with a leafy bracteole ½in. long just below the lowest pedicel. Flowers 10–15, alternate (not all unrolled), distant 3–4 lines apart on stem; pedicels slender, 2 lines long; calyx broadly campanulate, very rough and hairy, 2 lines long, cut halfway to base; lobes ovate subacute, ciliate, with a strong middle nerve, much veined with an intramarginal vein, veinlets anastomosing. Corolla twice as long as calyx, 5 lines diameter, reddish (dried, probably whitish or cream-coloured fresh); tube 2 lines long, very narrow; lobes large, broadly rounded and slightly retuse, much veined, veins anastomosing; scales of throat-margin rather large, kidney-shaped, slightly retuse. Anthers exserted, linear, tips subacute, bases hastate; style long; stigma small, clavate, bifid. Nuts broadly ovate, obtuse, turgid, pale-brown; testa very thin, semi-transparent, shining, showing seed within.

*Hab.* Ruahine Mountain-range, east side: *Mr. E. W. Andrews*; 1895.

## Order LIII. Scrophularineæ.

### Genus 7. **Veronica**, Linn.

1. *V. hillii*, sp. nov.

A small compact bushy shrub, 12in.–18in. high; whole plant glabrous. Leaves numerous, decussate, close-set 2 lines apart on branchlets, patent, subfalcate, oblong-lanceolate, 1¼in. long, 4½ lines wide, not narrowed into petiole, slightly laterally subrevolute not flat, thickish, opaque, dark-green above, pale-green glaucescent below, margins slightly dentate-serrate (5–8 serratures on each side); midrib stout, prominent below, thickened at tip, obtuse; petiole short almost subsessile, stout,

adpressed to stem. Flowers subterminal and subcorymbose, racemes axillary, slender, a little longer than leaves; peduncles very slender, ½in. long, bracteate, usually 4 pairs of bracts (sometimes binate, and also ternate), pedicels short, stout; bracteoles as long as sepals, thin; the two bracts of lowest pair of pedicels (also subpeduncles) nearly twice as long as bracteoles. Flowers white; sepals narrow sub-ovate-acuminate, 1½ lines long, thin; corolla 3 lines diameter, spreading, 4-lobed, lobes nearly alike narrow ovate-acuminate, tips incurved (sometimes rarely 3- and 5-merous), the lower lobe the smallest; tube sub 1 line long, wide, throat naked; style very long, more than twice as long as calyx; capsule broadly ovate-elliptic; seeds few, thin, flattish, rather irregularly shaped, suborbicular, broadly elliptic, and obovate, pale-brown, glabrous.

*Hab.* At Kuripapango, on the River Ngaruroro, in the hilly interior, County of Hawke's Bay: *Mr. H. Hill;* 1894.

*Obs.* I. A very graceful flowering-shrub, its flowers presenting a peculiar neat and striking star-like appearance. It will range naturally near to *V. colensoi*, Hook., and *V. darwiniana*, Col. (Trans. N.Z. Inst., vol. xxv., p. 331). In drying, the leaves lose much of their dark-green colour above, and become glaucescent.

II. Mr. Hill brought away living plants, which have done well in his garden at Napier.

2. *V. olsenii*, sp. nov.

A small neat prostrate shrub with short procumbent branches, rooting at nodes; branches slender, thickly pubescent, hairs short, patent; bark dark-red. Leaves rather close, opposite, subsecund, sub-rhombic-orbicular, 4 lines diameter, deeply cut, serrate, 3 teeth on the side (sometimes only 2), tip obtuse and subacute, glabrous, dark-green, thickish; petiole 1 line long, stout, canaliculate, glabrous edges pink. Flowers in slender erect axillary opposite peduncles 4in.–5in. high, the lower half (or more) naked, finely and closely pubescent (as also pedicels); flowers 15–20, alternate, rather distant, patent; pedicels 4–5 lines long, very slender, with a single sessile bract at the base (in one specimen 3 together subfascicled, with 3 bracts), bracts ovate obtuse $\frac{1}{10}$in. long, the lowest pair 2 lines long (rather large for so small a plant), glabrous, margined, margin ciliolate. Sepals large, rhombic-ovate, obtuse, glabrous, thick, the apical portion of margins glandular-ciliolate. Corolla small, sub 3 lines long; tube very short; lobes 4, 3 of them orbicular, 1 (the lower) oblong, tip rounded entire, conniving, white with a pink throat and a few faint pinkish dashes. Stamens inclosed, shorter than lobes; anthers cordate obtuse

style long, slender, flexuous, persistent; stigma simple. Capsule didymous, subpyriform, turgid, nearly twice as long as calyx (one specimen tri-celled). Seeds numerous, broadly elliptic-obovate, slightly turgid, dull-yellowish.

*Hab.* Ruahine Mountain-range, east side: *Mr. A. Olsen;* 1894–95.

*Obs.* I. The affinities of this neat little species are with *V. bidwillii* and *V. lyallii,* differing, however, from both in several characters.

II. Named after its discoverer, Mr. A. Olsen, of South Norsewood, a zealous collector and lover of plants, as many of them detected by him and described by me in this and in several preceding volumes of the "Transactions of the New Zealand Institute" bear ample witness. Of this genus, this species, with others, and many other plants from the mountain-ranges, flourish admirably in his well-stocked garden, the proximity to the mountain and its altitude being so suitable.

3. *V. marginata,* sp. nov.

A small shrub(?) (two specimens received by post); young branchlets 6in. long, simple, leafy alike throughout, bark pale-green, densely pubescent. Leaves decussate, spreading not crowded, 3 lines apart, broadly lanceolate, 1in. long, 4 lines wide, tips acute produced, bases abrupt subtruncate, chartaceous, bright-green on both sides, glabrous, not flat, slightly revolute; margins entire, hairy, their extreme lateral edges minutely and thickly pubescent, hairs greyish; midrib sunk and finely pubescent above, very prominent below, excurrent, thickened and subscaberulous at tip; petioles 1 line long, stout, broad, glabrous, their bases half-clasping and semiconnate. Flowers rather numerous, terminal in small close corymbs 1¼in.–2in. diameter, also axillary and subterminal in short deltoid distichous loose racemes, 1¼in. long and 1in. wide at base, 5-jugate; pedicels patent, 1½ lines long, glabrous (sometimes finely but thickly puberulent), each with a small linear-ovate bract at base minutely ciliolate (also sepals). Sepals 4, large, half as long as capsule, ovate-acute, spreading. Corolla large, sub ½in. diameter, tube, very short or 0, throat wide; lobes 4, suborbicular, entire, the lowermost one only a little smaller, largely veined; colour white slightly dashed with lilac. Stamens included, stout; anthers cordate, obtuse, dark-purple. Style 2 lines long, slender, curved; stigma small, simple. Capsule (immature) slightly inflated, broadly ovoid, 3 lines long. Seeds oblong-obovoid, turgid, glabrous, pale.

*Hab.* From garden of Mr. A. Wall, Porirua, near Wellington (per *Mr. R. C. Harding*); 1895.

*Obs*. A very distinct, striking, and graceful species, differing largely from all others known to me, but having some affinity with *V. elliptica*, *V. benthami*, *V. lævis*, and *V. buxifolia*. Its large flowers without tube (which makes them fugacious), 4-fid calyx with sepals large and sharply acute, elegant-shaped and symmetrically-placed leaves with their curious puberulous margins and produced tips, make the plant an attractive and pleasing object.

## Order LXVII. Thymeleæ.

### Genus 1. Pimelea, Banks and Solander.

1. *P. subsimilis*, sp. nov.

A dwarf shrub 10in.–12in. high, erect, stout; branches few, thick, short, scarred, densely clothed with patent white hairs between upper leaves; bark reddish, covered with minute black tubercles between scars. Leaves quadrifariously disposed, very close and imbricate, narrow oblong-ovate, 2–2½ lines long, tip obtuse, subsessile, concave, thickish, glabrous, reddish-brown (dried), midrib very stout and prominent below; petiole broad, thick, wrinkled; floral leaves 4, unequal, one being a very little larger and three smaller than those of the stem, but thinner, greenish, with lateral nerves visible. Flowers terminal in small corymbose heads, 4–8 together; receptacle hairy; perianth sub ½in. long, very hairy on the outside, especially at base, with long white hairs extending upwards; lobes pink-coloured, broadly ovate, tips ciliate. Anthers exserted, shorter than lobes, broadly ovoid, obtuse, cordate. Style included, length of tube, simple.

*Hab*. Ruahine Mountain-range: *Mr. H. Hill*; 1895.

*Obs*. A species having close affinity with *P. stylosa*, Col. (Trans. N.Z. Inst., vol. xx., p. 205), but of more robust habit, erect and simple, possessing much smaller leaves and flowers, with much longer white hairs, style included, &c.

2. *P. dasyantha*, sp. nov.

Shrub low, bushy, suberect, 12in.–15in. high, much branched; bark brown, striate; branches, leaves beneath, and flowers densely strigosely hairy; hairs very long, acute, pure white. Leaves numerous, subdecussate, slightly imbricate, and rather distant, broadly ovate and subacute, 4–5 lines long, glabrous and minutely subpapillose above, with thick white hairy ciliolate margins, subsessile; petioles small, thickish, reddish, glabrous. Flowers in small terminal heads of 5–9; receptacle densely hairy, hidden by long white hairs; floral leaves similar to stem leaves but rather smaller. Perianth small, oblong, 3 lines long, sessile, hairs extending

nearly 1 line beyond lobes; tube 2 lines long, veined within; lobes very small, broadly oblong, $\frac{1}{18}$in. long, reddish, veined. Anthers sub-oblong-ovoid, red, connective very small, apicular. Style rather long, flexuous; stigma capitate, papillose; anthers and style exserted equal lengths. Ovary dark-green, subobovoid, hairy at top.

*Hab.* On stony dry ridges near the River Waimataa, County of Patangata (the provincial boundary between Hawke's Bay and Wellington): *Mr. H. Hill*; November, 1895.

*Obs.* I. On one of the branchlets, directly under the largest head of flowers and entirely concealed by it, I found two young branchlets a few lines in length, full leafy; showing that, shortly, that terminal head of flowers would become axillary in the fork occasioned by those two branchlets; and, further, in looking over the specimens I found the dead remains of receptacles of flowers in the axils of the old branches, confirming the same. I had, however, noticed that peculiar character before in *P. dichotoma*, a much larger species (Trans. N.Z. Inst., vol. xxii., p. 485).

II. This species will rank near to *P. arenaria*, A. Cunn., which, *primâ facie*, it much resembles.

## Class II. MONOCOTYLEDONS.

### Order I. Orchideæ.

### Genus 12. **Pterostylis**, Br.

1. *P. venosa*, sp. nov.

Plant small; leaves 2 near the base of the stem, suborbicular-oblong, 1¼in. long, 1in. wide, very membranous, largely veined, veins prominent anastomosing, areoles large subquadrilateral; petioles also veined, broad, loose, clasping, with 2 sheathing-scales at base. Scape 2½in. high, naked. Galea erect, ¾in. long, hood-shaped, greenish; dorsal sepal ovate-acuminate, obtuse; lower lip small, cuneate, sub ½in. long, ascending, with 2 linear-ovate lobes, tips finely acuminate, extending a little beyond dorsal sepal; petals ½in. long, sub-linear-spathulate with an obtuse angle produced on outer edge near the middle, tips broadly truncate. Labellum sub ½in. long, purplish, ovate-acuminate, parallel-veined, tip very slender, slightly exserted. Column sub ½in. high, very slender, wings with lower lobes oblong-obtuse, upper lobes, or teeth, short, narrow, acute.

*Hab.* Ruahine Mountain-range, east side: *Mr. A. Olsen*; 1894.

*Obs.* I have only received two specimens of this little plant, and they are very similar; unfortunately, though whole and perfect, they have been pressed very much in drying, so

that it has been a difficult matter to ascertain correctly their finer internal construction, on which so much depends, and I have only dissected one of them.

2. *P. subsimilis*, sp. nov.

Plant 8in. high. Leaves, radical 0; stem-leaves 5, distant, lanceolate, much acuminate, the 4 uppermost 4in. long ¼in. wide, the lowest leaf small and narrow 2in. long, sessile, half-clasping, very membranous; midrib slight; veins distantly reticulated, forming long areoles; near base of the stem 3 short sheathing-bracts. Scape slender, 1-flowered. Galea erect, curved; dorsal sepal 2in. long, very acuminate; petals linear-lanceolate, 1¼in. long, acute; lower lip deltoid, 2in. long, its two lobes long and slender with filiform red tails embracing galea; labellum red, ¾in. long, lanceolate, veined; veins parallel; midrib stout, minutely papillose, tip truncate; appendage broadly cuneate, curved, trifid, tips fimbriate; column erect, wings large 3½ lines long; lower lobes much produced, obtuse, rounded; upper lobes or teeth very narrow, erect, shorter than column; the uppermost dorsal margin of wings rounded and free from column; anther-hood large, erect, concave, apicular, reddish; stigma long, wider than column. Ovary 7 lines long, very slender.

*Hab.* Ruahine Mountain-range, east side: *Mr. A. Olsen;* 1894.

*Obs.* A species *primâ facie* resembling *P. speciosa*, Col. (Trans. N.Z. Inst., vol. xxii., p. 488).

Order VII. Liliaceæ.

Genus 5. **Astelia**, Banks and Solander.

1. *A. minima*, sp. nov.

Plant very small, tufted; rootstock not woody, coalescent, softish, 3in. (*et alt.*) long. Leaves (5) linear, 1½in.–1¾in. long, 1½ lines broad, tips acuminate, acute, margins recurved, midrib very prominent below, scurfy with long white shining irregular scaly hairs above (also the scape, pedicels, and flowers), but glabrous below and nerved, their bases thickly covered with long silky white acuminate scales, and the young leaves densely margined with reddish shining scales. *Male:* Scape slender, as long as leaves, forked about the middle, on one arm 3 and on the other 2 flowers, with 1 flower in the axil of the fork; flowers distant, free, on long pedicels; a long linear leaf-like bract at base of fork, and a smaller filiform one at base of lowest pedicel; pedicels 1½ lines long. Perianth spreading, 3 lines diameter; segments narrow ovate-acuminate, the 3 inner narrower, each with a little knob near apex within. Anthers elliptic, emarginate,

green, much shorter than ovary; style short and thick; stigma coarse, truncate, obsoletely 3-angled. *Female:* Only imperfect and damaged flowers seen.

*Hab.* Ruahine Mountain-range, east side: *Mr. H. Hill*, 1895; *Mr. E. W. Andrews*, 1895.

*Obs.* This is another small mountain species, allied to *A. linearis*, Hook., of the same mountain-range (and also of the Antarctic Islands, Auckland, and Campbell's); to *A. alpina*, Br., of Tasmania; and to *A. pumila*, Br., of Fuegia and the Falklands; but differing from them all. Of the specimens received, the *female*-flowered plants were much damaged and past flowering; sufficient, however, remained to show their great difference from their congeners.

## Order XI. Cyperaceæ.

### Genus 14. **Carex**, Linn.

1. *C. inconspicua*, sp. nov. (*non* Steud.).

Plant very small, 1¼in.–1½in. high, erect, thickly cæspitose. Leaves very narrow, filiform, semiterete, canaliculate, irregular in length, finely serrulate at top, tips obtuse, green, sheathing below, 6–8 together. Culms a little longer than leaves; spikelet solitary, small, 1 – 1½ lines long, broadly cuneate, spreading, usually 4 together; the two outer scales long, bract-like, the outermost ¾in. long, tip stout, obtuse; the next ½in. long, tip slender, acute, both finely serrulate. Glume rather large for plant, ovate-acuminate, brown, enwrapping, margins membranous, tip much produced, serrulate. Utricle ovoid acuminate, tip 2-fid, lobes long sharp pointed serrulate. Style long, margins serrulate; stigmas 3 (sometimes 2), dark-brown, long, rough, curved.

*Hab.* Ruahine Mountain-range, east side: *Mr. A. Olsen*; 1895.

*Obs.* Allied to *C. acicularis*, but a smaller plant, without the linear scale of that species, with differently-shaped spikelet, long style, &c.

## Order XII. Gramineæ.

### Genus 16. **Danthonia**, De Candolle.

1. *D. nervosa*, sp. nov. (Col., *non* Hooker).

Plant small, tufted; rootstock hard, slightly knobbed, much branched; branches short, patent, spreading and ascending, with many white glabrous sheathing striate bracts at bases of leaves and clothing nodules. Culms erect and drooping, 7in.–9in. (rarely 12in.) long, slender, almost filiform, glabrous, striate, pale-green, nodes blackish, with three short stem-leaves nearly equidistant. Leaves few, one-third

length of culms, 1 line wide at base, sub ½ line wide above, largely striate, tips subacute, whitish, callous, pale-green, subglaucescent, scaberulous dotted between striæ below, closely revolute, finely hairy, largely sheathing, orifice of sheath very hairy within. Raceme small, rather narrow, 1in.–1¼in. long, minutely scaberulous, bearing 5–7 upright pedunculate spikelets; at base a long leaf-like sheathing bract, tip truncate with erect ciliæ; peduncles 1 line long scaberulous and slightly hairy, with a long linear scarious bracteole at base. Spikelets not crowded, obovate, suberect, 4 lines long, containing 3–5 florets, with a small linear membranous bracteole at base; glumes and awns pale-green dashed with purple; outer empty glume 3 lines long, ovate, 10-nerved, nerves bright-green, prominent, each forming a double line, margin ample membranous, shining, white, tip obtuse its margin scaberulous; second empty glume margins scabrid, tip jagged; white hairs around base. Flowering-glume deeply 2-fid, lateral awns very long, longer than glume and nearly as long as central awn; central awn long, flat, dark-brown, shining and twisted below; awns scabrid, erect; two bundles of long hairs on lateral margins of glume, hairs rigid, unequal, scaberulous, acute. Palea subobovate, margins sparingly hairy; tip bifid, rigid-ciliolate. Ovary obovate, brown, tip bi-cornuted to base of styles; stigmas slightly branched at top, branches long, flexuous, strangulated.

*Hab.* Dry hills, altitude 1,000ft.–3,000ft., Hawkston, County of Hawke's Bay: *Mr. Thomas Hallett*; 1894–95.

*Obs.* I. The affinities of this species are with *D. racemosa*, R. Br., and *D. penicillata* (*Arundo penicillata*, Labill., Pl. Nov. Holl., i., 26, tab. 34), but differing in several characters. Specimens received were obtained after flowering.

II. Mr. Hallett kindly informs me that this grass makes a close sward, but every plant only grows in its own simple tuft. Cattle and sheep are very fond of it, and crop it closely. It grows well during winter, and is about equal to most other grasses during summer for grazing purposes; and even while being closely grazed it perfects seed, owing to its habit of sending out many of its culms horizontally. A valuable grass on unploughable hills.

ART. LIX.—*New Zealand Cryptogams: A List of a Few Additional Cryptogamic Plants, of the Orders* Hepaticæ *and* Fungi, *more recently detected in New Zealand.*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 21st October, 1895.*]

DURING the last year (1894) I sent to Kew several parcels of cryptogamic plants that I had collected during preceding years in the bush district of Hawke's Bay; mosses and lichens formed by far the larger portion, with some *Hepaticæ* and *Fungi*. From letters since received from the director there, I find the following species were determined as being new to the botany of New Zealand. The *Hepaticæ* (as on former occasions) were submitted to Dr. F. Stephani, of Leipzig, for examination and report:—

HEPATICÆ.

Plagiochila olivacea, *Steph.*, sp. nov.
Jamesoniella patula, *Steph.*
Frullania kirkii, *Steph.*, sp. nov.
Trichocolea tomentella, *Sw.*, alpine form.
Metzgeria furcata, *var.* nuda.

Of *Hepaticæ* there were 112 distinct packets (many being duplicates, in fruit, &c., of those formerly sent), but of them these five were not received before, and only two of them were *species novæ*.

FUNGI.

Agaricus (Leptoma) lampropus, *Fr.*
A. (Omphalia) pyxidatus, *Bull.*
Flammula xanchophylla, *Cooke and Mass.*
Polystictus pinsitus, *Fr.*
P. citreus, *Berk.*
P. occidentalis, *Kl.*
Favolus hepaticus, *Kl.*
Irpex flavus, *Jungh.*
I. sinuosus, *Fr.*
Corticeum lacteum, *Fr.*
Clavaria juncea, *Fr.*
Bovista amethystina, *C. and M.*
Æcidium epilobii, *DC.*
Peniophora gigantea, *Mass.*
Tremella mesenterica, *Fr.*
Hydnangium brisbanense, *B. et Br.*
Stemonitis fusca, *Roth.*

Rhizopus nigricans, *Ehr.*
Mucor mucedo, *L.*

With several others (*Fungi*) that were duplicates of species formerly sent, together with some that were immature, imperfect, mycelium only, and not determinable.

One species in particular of this named lot deserves a passing special mention—viz., *Hydnangium brisbanense*—as this curious species I found here at Napier in my house-paddock, growing pretty plentifully on the ground under the shade of some large blue-gum trees (*Eucalyptus globulus*), where I had never noticed it before. It is, as its specific name denotes, an Australian species. Other Australian species (*e.g.*, *Polystictus citreus*, *Irpex flavus*, *Stemonitis fusca*, &c.) were also among the little lot sent, obtained by me from the distant forests; but this one is a species of a more especial and small Australian genus, two other species of this genus being also known—*H. tasmanicum*, Kalch, and *H. australiense*, Berk. (this last, however, was subsequently removed by Berkeley himself into an allied Australian genus, *Octaviana*). This is also the second time that I have found peculiar Australian species of *Fungi* here at Napier on the bare ground under blue-gum trees. Of course, I do not mean to imply there is any connection, anything regular, natural, or occult in the circumstances ("There is a river in Macedon; and there is also a river at Monmouth; but 'tis all one: and there is salmons in both," as Shakespeare has it); but it almost seems like a peculiar concatenation of secret natural phenomena—which, though at present merely noticed, will probably hereafter become elucidated.

ART. LX.—*Cryptogams: A Description of Two New Ferns, a New* Lycopodium, *and a New Moss, lately detected in our New Zealand Forests.*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 21st October, 1895.*]

Class III. CRYPTOGAMIA.

Order I. FILICES.

Genus 16. **Lomaria**, Willd.

1. *L. distans*, sp. nov.

Plant small, tufted, glabrous. Rootstock slender, woody, hard, black, composed of coalesced stipites, thickly clothed

with scales, which are also sparingly scattered on stipe; roots descending, wiry. Fronds erect, submembranaceous, dull-green (dried), linear-lanceolate; stipe and rhachis very slender, almost filiform, smooth, deeply channelled, dark-brown. *Barren fronds* various sizes, 2½in.–5in. long, 4–5 lines broad, sometimes subhorizontal and spreading, rhachis flexuous, pinnatifid; lobes numerous, cut nearly to rhachis (and generally distinct in middle of frond, almost pinnate (*pinnato-pinnatifid*), as shown by the small red marginal line of separation between them), not close, sinuses broad; inferior lobes opposite; superior alternate and zigzag, deltoid and oblong, sessile, adnate, margins recurved, sub-crenulate-toothed, their tips pointed with a tooth, coarsely veined; veins forked, usually 3-jugate, not extending to margin, tips clavate and subtranslucent; apical lobe short, narrow, acuminate acute. *Fertile fronds* twice as long as barren, stipe very long usually 5in.–6in., pinnate; pinnæ opposite, distant 2–3 lines apart on rhachis, very small, 2 lines long, sub 1 line wide at base, narrow deltoid-acuminate, falcate reversed, adnate and continuous produced upwards on rhachis (*sursum currens*), subrugulose, margins irregularly undulate; tips pointed; dark-brown. Involucre large, inflated, pale-brown, margin laciniate and overlapping. Sori numerous, covering whole under-surface of pinna; sporangia on long pedicels. Scales deltoid, obtuse, cordate, half-clasping, fawn-coloured.

*Hab.* Ruahine Mountain-range, east side: *Mr. H. Hill*; 1894.

*Obs.* This species will rank near to *L. alpina*, Sprengel, and to *L. parvifolia*, Col. (Trans. N.Z. Inst., vol. xx., p. 224), and their allies, differing widely, however, in several characters, especially in position and peculiar formation and habit of its fertile pinnæ, their superior bases running upwards on rhachis, instead of downwards.

2. *L. alternans*, sp. nov.

Plant small, tufted; rootstock ascending, coalescent; roots long, branched, densely clothed with red woolly hairs; fronds (sub 20) erect and spreading, lanceolate, glabrous; stipites very hairy at base, scales dark-brown, long and coarse, shining, ¼in. long, 1 line broad at base, subulate, very narrow acuminate; veins longitudinal, close, coarse; veinlets anastomosing. *Barren frond* pinnatifid, membranous, green, 7in.–10in. long (including stipe 2½in.), ¾in. wide (at middle); lobes alternate, regularly zigzag throughout, oblong-deltoid, tips rounded, midribs ascending, margins undulate subcrenulate with minute callous teeth (3–4–5 together) at tips of veins; veins few, free, distant, and forked, extending to margin, tips clavate, the

lower pair not arising from midrib; sinuses short, rather narrow; lobes very small at base, sub 1 line long; apical lobe sub 1in. long, ovate, tip obtuse; rhachis slender, channelled, colour of frond; stipe stout at base, purple-brown. *Fertile frond* (usually shorter, but some as long as *barren*) ascending, flexuous, very slender (filiform) sub ⅛in. wide, pinnate below; lobes very small, distant, and opposite, forming little balls of sori around rhachis, pinnato-pinnatifid above, ¼in. apart, very narrow, sub 1 line wide, adnate, largely decurrent also current upwards. Involucres narrow, entire, continuous to very tip.

*Hab.* On slopes near the sea, Weber district, East Coast, County of Patangata: *Mr. H. Hill;* November, 1895.

*Obs.* This species approaches near to *L. aggregata*, Col. (Trans. N.Z. Inst., vol. xx., p. 223), but differs in several constant characters, apparent on close comparison. It is also naturally allied to some other of our small *Lomariæ*, as *L. lanceolata*, Spreng., *L. membranacea*, Col., *L. pumila*, Raoul, *L. oligoneuron*, Col., and *L. intermedia*, Col. (*loc. cit.*).

## Order II. Lycopodiaceæ.

### Genus 2. **Lycopodium**, Linn.

§ III. Leaves imbricated all round the stem; spikes terete, peduncled.

1. *L. decurrens*, sp. nov., Col. (*non* Brown).

Plant small, 1½in. high erect (a single specimen gathered without basal portion), 4-branched, three of its branches being forked, main stem and branches leafy alike, branches sub 1in. long spreading. Leaves quadrifariously disposed, loosely imbricate, erect and subflexuous, subulate, 2 lines long; tips acute, slightly incurved, dull-green, glabrous and shining; peduncles terminal, slender, erect, ½in. long, striate, pale, dry, bracteate; bracts linear, subopposite, 2–3–4 together, distant, pale, rather thin; tips obtuse. Spikes solitary, sub 1in. long, narrow linear, $\frac{1}{10}$in. wide, brownish. Scales small, peltate, subsquarrosely spreading, ovate-acuminate, $\frac{1}{10}$in. long, tips acute, bases rounded and much produced, slightly toothed, thin; the uppermost scales with tips less acuminate, obtuse, dilated, and thin, their lower lateral margins slightly toothed. Capsule narrow reniform, ½ line long, glabrous.

*Hab.* Ruahine Mountain-range, east side: *Mr. E. W. Andrews;* 1895.

*Obs.* A species very near to *L. scopulosum*, Col. (Trans. N.Z. Inst., vol. xx., p. 234), and to its allies, as mentioned there.

## Order IV. Musci.

### Genus 55. **Cryphœa**, Mohr.

1. *C. novæ-zealandiæ*, sp. nov.

Plant tufted, erect, and slightly drooping; dark-green. Stems 2½in.–3in. long, leafy from base, branched; lower branches few, distant, sub ¼in. long, each bearing 6–8 capsules; upper branches numerous, close, and very short, subsecund, each with a capsule at apex. Leaves subrhomboidal, margins entire, nerve very stout extending to margin, apex obtuse; perichætial oblong-ovate, margins entire, very acuminate soon subulate, the subulate portion longer than lamina, tips obtuse; cells narrow linear throughout. Capsule erect, broadly oblong, turgid, slightly sulcate, reddish (so, also, operculum), half concealed by perichætial leaves; operculum slightly conical from a broad base, depressed, with a rather long acute beak; annulus dark-coloured; teeth exserted, white.

*Hab.* Ruahine Mountain-range, east side: *Mr. A. Olsen*; 1895.

*Obs.* A species near to *C. tasmanica*, Mitt., which it much resembles in size, form, and habit, differing, however, in shape of leaves, with their nerve extending throughout, their very blunt apices, and entire margins, as well as in the form of capsule, of operculum, &c.

## Art. LXI.—*A Description of Three Ferns, believed to be Undescribed, discovered more than Fifty Years ago in the Northern District of New Zealand.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 21st October, 1895.*]

### Genus 4. **Trichomanes**, Smith.

1. *T. polyodon*, sp. nov.

Plant terrestrial, small, tufted, 6–8 fronds, erect, spreading, and slightly drooping, 3–5in. high (a single specimen without basal end 6½in., the stipe being 3½in.), colour darkish olive-green (? from long keeping), with a roughish appearance. Frond ovate-acuminate, 2½in.–3in. long, 2in.–3in. broad, membranous, bipinnate; pinnæ alternate, close, slightly imbricate, erect, patent, subfalcate, the lowermost pair subopposite, the next pair longest, pinna ovate acuminate obtuse, the inner pinnule

longest; segments cuneate, the terminal one large oblong, much laciniate, midrib flexuous branched; veins numerous, erecto-patent, stout, dark-coloured, prominent on both sides, free, venules marginal, sometimes forked at tips, excurrent, mucronate-serrate; rhachises sparingly hairy, not winged, but the upper pinnæ and pinnules slightly subpinnatifid above at axils (*sursum currens*), hairs long slender flexuous; stipe 1½in.–2in. long, firm, dry, slender, when young reddish and very hairy, hairs 2–3 lines long curved dark-red, fugacious in age. Involucre free, narrow infundibuliform, 1 line long, few, solitary on inner margin of segment, reddish; mouth open, thin, entire or slightly uneven, receptacle stout, sometimes exserted as long as involucre. Rhizome short, stout, very hairy; hairs long, enwrapping, dark, coarse. Roots stout, black, numerous, descending.

*Hab.* Country between lower Waikato (N.), head of Thames, and Kaipara; 1843–44: *W. C.*

*Obs.* This species will rank with *T. elongatum* and *T. colensoi*, but is very distinct from both. Its specific differential characters are good, well defined, and constant; in its peculiar and strongly-marked venation and curiously-webbed axils I know of no other species of the genus, nor of any other New Zealand fern, that approaches it; the cellular structure of the frond is also peculiar, constituting regular and large areolæ.

### Genus 13. **Cheilanthes**, Sw.

1. *C. erecta*, sp. nov.

Plant small, usually sub 6in. high (a single specimen among many 8in.); tufted, erect, light-reddish-brown. Frond linear (scarcely sublanceolate), obtuse, 3in.–3½in. long, 6–8 lines broad; rhachis red-brown, shining, sulcated; stipe 2in.–2½in. long, slender, brittle, glabrous, shining, light-brown, slightly scaly, bipinnate or subtripinnate; pinnæ 8–10 pairs, distant, opposite, deltoid and subtrapeziform, obtuse, patent and suberect, diverging, thickish, flat, glabrous above, densely paleaceous-scaly below; veins few, free, dichotomous, obsolete; the lowermost pair of pinnæ smaller than the next and more distant (1in.) on rhachis; pinnules few, lowermost pair pinnate, each one composed of 3 segments, the two basal segments (or lobes) small roundish, the terminal one deltoid-acuminate and subovate, obtuse; upper segments (or lobes) sessile, opposite, sub-oblong-ovate, falcate, obtuse; apical segments of frond very small. Involucre narrow, membranaceous, continuous, entire and slightly sinuate and finely crenulate. Sori copious, pale, spreading. Scales long, sub-ovate-acuminate, flat, thin, shining, striate, flexuous, spreading, pale-brown, very close, sometimes entirely covering pinna below. The pairs of pinnæ have a peculiar regular 4-angled

somewhat semicruciform appearance, with lower pinnules largely diverging.

*Hab*. Same general locality as preceding; 1843–44: *W. C.*

*Obs*. This fern might be just as well placed in the genus *Pellæa*, though its habit is more that of several of the *Cheilanthes* genus; its *primâ facie* appearance is much like *Nothochlæna distans*. It is a very distinct species, and, fortunately, I have several specimens of it.

### Genus 27. **Lygodium**, Sw.

1. *L. gracilescens*, sp. nov.

Plant glabrous, stems long slender numerous, twining and climbing high. *Barren frond:* Petiole slender, patent, 1¼in. long, forked, diverging, each secondary petiole 4–5 lines long, bearing 5 submembranaceous pinnules linear-acuminate 2¾in.–3½in. long, 5–7 lines wide, slightly subsinuate, margined, tip subacute, base truncate, sometimes bilobed nearly to base, petiolulate; petiolules 1–2 lines long, filiform, flat above with raised margins, semiterete below; midrib undulating, shining, light-fawn-coloured; much veined; veins alternate, free, 2–3 times forked, extending to margins, stout, prominent on both surfaces; the lowest pair of veins springing from the petiolule, which is largely articulated all round, forming a kind of little cup. *Fertile frond* flat, largely compound, zigzag, divaricate, loose, graceful, variously shaped in outline, generally parallelogramic, 4in.–5in. long and nearly as broad, containing 40–100 distinct distant free lobes or small pinnules, patent at right angles, of various shapes and sizes, 3–9 lines diameter, flabelliform, subtrapeziform and subpalmate, largely irregularly laciniate and squarrosely slashed, with more or less of lamina in the centre, and much veined, each on a filiform rhachis or petiolule, finely striate and shining; each pinnule bi- and tri-foliolate, when the latter then bipetiolulate with 2 folioles or pinnules springing from a single petiolule, and each distinctly stipitate, and often with two branched midribs from base, largely articulated as in barren frond, each pinnule bearing 20–30 (and upwards) small crowded marginal spike-like clusters at tips of veinlets, subglobular, oblong and turbinate, each cluster or spikelet containing 4–8 sori; involucres glabrous, tips obtuse; capsules smooth, shining, striate; spores white, glabrous. Colour of pinnules rich dark-brown above, glaucescent below; of involucres, orange with large black spots.

*Hab*. Same general locality as the preceding two ferns; 1843–44: *W. C.*

*Obs*. This plant has given me some trouble, from its somewhat resembling the well-known New Zealand species, *L. articulatum*, A. Richard. Fortunately, however, I possess

Richard's folio copperplate engraving with dissections of that species, and, on a close and prolonged examination and comparison, I find the differential characters to be both clear and constant: I have given them in my rather long description. I also possess good drawings with dissections of several other species, as *LL. flexuosum, dichotomum, javanicum, scandens, volubile*, and *reticulatum*, all differing.

The history (so to speak) of these three ferns is somewhat peculiar, and therefore may be briefly narrated.

In my preparing a paper recently for our society, "On the Tin-mines and Mining of Cornwall" (England), I recollected that I possessed a collection of minerals—tin and copper, lead and iron ores—that I had received from Home in the early days (somewhere in the thirties), but I did not know in which of my old unopened cases to find them. On opening one at a guess, I found it was not the one that I wanted, but it contained a heterogenous lot of all sorts—"odds and ends," pamphlets, letters, small boxes, and Maori curios, and several specimens of dried plants still in very good condition, although they were certainly more than fifty years old, the box having been packed by me in 1844, on leaving the Bay of Islands for Hawke's Bay, and not since opened. Among those specimens were these three ferns (with several others—known ones), and a few Phænogams. I have endeavoured to recollect the exact localities where I had met with them, but in vain. Yet, while such is obscure, from some other specimens put up with them, as *Adiantum æthiopicum*, and *Grammitis leptophylla* (*G. novæ-zealandiæ*, Col.), both in great plenty, whose special habitat I well remember—between Auckland and the head of Manukau Harbour—and also from specimens of *Alseuosmia banksii* and *Pennantia corymbosa* (all then rare with me at the north), I know that these three ferns here described must have been also found in that country or district named—and probably near the end of my long journey overland from Hawke's Bay to the Bay of Islands in the years 1843–44. Moreover, on my arrival there in February, being beyond my fixed time, and having very much of other and far different matters to attend to, those specimens were put aside and forgotten.

Further, I cannot but believe that specimens of these three ferns must have been again met with during the last fifty years by the many fern-collectors and amateurs in that now well-known district, and, if so, probably placed under other and allied species—as *Trichomanes* under *T. elongatum*; *Cheilanthes* under *C. tenuifolia*, or *Nothochlæna distans*; and *Lygodium* under *L. articulatum*—as there is a kind of family resemblance between them at first sight and without close

examination which might suffice to class them as varieties of those well-known and allied species.

In fine (and as it is very likely I may never again have the opportunity of describing any more of our New Zealand ferns), I would venture to repeat what I wrote last year respecting the proper study of ferns, believing such to be absolutely necessary in arriving at a just conclusion concerning them: "I have long been of opinion that greater scrutiny should be given by pteridologists (not mere amateurs, fern-growers, and collectors) to the scales of ferns—their form, consistency, venation, colour, and structure. Nature is ever great, true, and constant in what men term *small* things." (Trans. N.Z. Inst., vol. xxvi., p. 400.) In so saying I merely re-echo the opinions and words of two of our most eminent British pteridologists—Sir W. J. Hooker, formerly the director of the Royal Botanic Gardens at Kew, and Mr. John Smith, for forty years his able and intelligent curator of ferns there, and also author of several useful works on ferns. And with these words of Sir William Hooker's (used in describing one of our New Zealand ferns—then, as *Polypodium attenuatum*, but now, and correctly, as *P. cunninghamii*) I close my paper: "The nature of the *venation* is of the highest importance in the study of the ferns—sometimes for discriminating species, and not unfrequently for distinguishing genera" ("Icones Plantarum," tab. CDIX.).

## Art. LXII.—*Note on a Branched Specimen of a Tree-fern* (Hemitelia smithii).

By A. Hamilton.

[*Read before the Otago Institute, 8th October, 1895.*]

A specimen of what must have been a beautiful natural curiosity has recently been brought to the Otago University Museum, and, as the number of branches or divisions of the trunk is very unusual, I have been permitted by the director, Dr. Parker, to submit a short note on the specimen, with a diagram showing the different divisions.

The fern originally grew, I believe, on the slopes of Mount Cargill, and, after a long life of beauty, fell a victim to the axe of the settler in the progress of settlement, as did one of even greater dimensions about ten years ago.* It is to be hoped

* "On a Remarkable Branching Specimen of *Hemitelia smithii*. By John Buchanan, F.L.S." (Trans. N.Z. Inst., vol. xix., p. 217, pls. xii. and xiii.)

that, should others of this character be found, some steps may be taken to preserve them, even at the risk of transportation to the town Gardens.

The trunk is simple for about 2½ft.; but I am unable to say how much was left on the stump or removed before the specimen reached the Museum. It then commences to divide into eight nearly equal divisions, five of which are united together almost in one plane; the other three are more or less separated. The average height of these divisions is about 4ft.

## ART. LXIII.—On *Cordiceps robertsii*.

By H. C. FIELD.

*[Read before the Wellington Philosophical Society, 31st July, 1895.]*

THE term "vegetable caterpillar" is a corruption of the old name of "vegetating caterpillar," by which the Sphœria was called forty or fifty years ago by those colonists who then took interest in scientific matters, and which properly describes the curiosity as a caterpillar which apparently developes into or produces a plant. I think it a pity that our Transactions should be disfigured by a vulgar corruption, however common.

Sphœrias are far more common than is generally supposed. As many as fifteen or twenty have occasionally been found, in my presence, in the course of a few hours, when forming a short length of side-cutting, and no doubt many others were dug up without being observed. This has always occurred in koromiko scrub or the lightest of scrubby bush—rangiora, karamu, tutu, &c. Though I have heard it asserted that Sphœrias were generally found under rata-trees, I never yet met with one in such a situation, but have often seen them dug out in places a mile or more from a rata. Although, as a rule, there is only one shoot, and that proceeding from the back of the caterpillar's neck, yet an instance is recorded, I think in our Transactions, of shoots proceeding from both ends of the insect. It often happens, too, that, if the original shoot has been broken off by any accident, a second one springs up alongside it to replace it. Again, it is by no means unusual for the shoot to fork above ground and produce two spikes of sporangia, and these sometimes fork again; so that, in one instance which one of my sons found at Momahaki, beyond Waitotara, there were eight or more spikes.

As regards the main question started in Sir W. Buller's paper,* I may note that, if a Sphœria is divided longitudinally,

* Trans. N.Z. Inst., vol. xxvii., art. xii.

it will be found that the alimentary canal of the insect still remains perfect, only the flesh having apparently been converted into the white cork-like vegetable substance. Outside of this there is a thin brown covering, which I have always regarded as the skin of the insect; and, as this is thicker and darker in colour at the horny portions, such as the head and feet, and these retain their exact form, even to the claws of the feet, I do not think that any one would be likely to regard them as other than remaining portions of the original insect. The total quantity of them, however, is so small that I hardly fancy that they would give any appreciable result to a chemical test, such merely as the smell of chitine when burnt.

I have usually seen Sphœrias dug out in the late autumn and early winter months. In earlier autumn they are of a green tint, and so are more liable to escape notice; and earlier still in the season I have often seen the live caterpillars dug out. They are of about the colour of parchment, and might easily be mistaken for silkworms. I believe that the Maoris are right in stating that they are the larvæ of the large green night-moth *Œpialus*; yet, in the course of the many years during which I lived for the most part in the bush, and kept a look-out for them, I never saw the caterpillars feeding on the leaves of plants of any kind, though the *aweto* (larva of the sphinx-moth) may often be observed on the convolvulus, particularly on the stunted form which grows among the sandhills near the sea-coast. Some people fancy that the *aweto* is the vegetating caterpillar; but this is a mistake—they are quite different; and the former is unmistakable, from its larger size, varying colours (green, yellow, or reddish-brown), and particularly by having a sort of horn growing erect on the tail-end of the insect.

# IV.—GEOLOGY.

## Art. LXIV.—*Notes on some Rocks from the Kermadec Islands.*

By R. Speight, M.A.

[*Read before the Philosophical Institute of Canterbury, 2nd October, 1895.*]

By the kindness of Captain Hutton I have been allowed to examine some specimens of rock in the Canterbury Museum which were brought from the Kermadec Islands by Mr. Park. The specimens are all small, and I have been unable to do more than examine them microscopically. I have been unable to identify them completely with any of those described by Professor Thomas in the "Transactions of the New Zealand Institute," vol. xx.,* though some of them correspond in part. They are all volcanic, and belong to the intermediate division, with the exception of the first, which is a doubtful tachylyte. They all exhibit rather higher specific gravities than is usual in such rocks.

**Tachylyte** (Macaulay Island).

This specimen is from Macaulay Island. It is black in colour, and has the lustre of pitchstone. Its specific gravity is 2·49, which is rather low for a basalt-glass, but corresponds to the value for a tachylyte. It fuses under the blowpipe, but does not dissolve to any great extent in hydrochloric acid; though after digesting the powdered rock for several days with this acid a quantity of iron was dissolved out. It thus corresponds with tachylyte as regards specific gravity and fusibility, but differs as regards solubility. However, the last does not appear to be at all constant in the case of rocks which are undoubtedly tachylytes.

Under the microscope in ordinary light it is brown in colour, with numerous small grains of magnetite and microliths of feldspar, the arrangement of which shows well marked fluxion structure. It is rather opaque, and only very thin sections transmit light.

With polarized light crystals of augite, feldspar, and magnetite are visible, though none of them are large enough to be

* See Trans. N.Z. Inst., vol. xx., art. xli., "Notes on the Rocks of the Kermadec Islands," by Professor A. P. W. Thomas, M.A., F.L.S., &c.

seen with the naked eye. The feldspar is probably labradorite or anorthite, as the method of determination by the extinction of twin lamellæ gave very high angles. Some of the crystals exhibit zonal structure. The crystals of augite are small and occasionally twinned. The ground-mass consists almost wholly of glass, in which are feldspar microliths and grains of magnetite. The rock must therefore be classified as a volcanic glass, and the presence of magnetite and augite shows that it belongs to the basic series. From its chemical and physical properties it would probably be called a tachylyte. This rock appears to be the same as that described by Professor Thomas, but I did not notice the pleochroic mineral mentioned by him.

**Andesite** (Macaulay Island).

This rock is dark in appearance, and has a specific gravity of 2·87. Small crystals of porphyritic feldspar are visible to the naked eye. On examining it microscopically this appears to be the only porphyritic mineral, though the specimen was so small that others might very well exist. The angles of extinction were again high, so that it is probably labradorite or anorthite. The feldspar is not weathered, and contains numerous small inclusions, and often shows undulose extinction. The ground-mass is semicrystalline, and contains microliths of feldspar and other dark material. The rock appears to belong to the andesite group, both from its specific gravity and its microscopic appearance; but the absence of any ferro-magnesian mineral renders its accurate classification difficult.

**Augite-andesite** (Macaulay Island).

The external appearance of this rock is dark-grey, with feldspar crystals plainly visible. The specific gravity is 2·7. On examining it microscopically it appears to be composed of a semicrystalline ground-mass, with porphyritic crystals of feldspar and augite. The feldspar is in moderately large crystals up to ¼in. in length. They are clear and free from inclusions. The extinction-angles render it probable that it is labradorite or anorthite. The crystals of augite are small. The ground-mass is full of grains of magnetite and feldspar microliths; very little glass is present. The rock therefore appears to be an augite-andesite.

**Andesite** (Sunday Island).

This specimen was much weathered, and an accurate description is therefore difficult. It is light-grey in colour. Specific gravity, 2·55. Crystals of feldspar are visible with the naked eye, and under the microscope show the twinning of plagioclase. From the extinction-angles it is probably lab-

radorite, though they are by no means so high as those of the feldspar in the other rocks. The only other porphyritic mineral observed was augite, but the crystals were very small. The ground-mass is semicrystalline, and full of dark grains, probably of magnetite. The general appearance of this rock and its specific gravity render it probable that it is an augite-andesite.

## ART. LXV.—*On a Deposit of Moa-bones at Kapua.*

By Captain F. W. HUTTON, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 7th August, 1895.*]

Plate XXXVI.

IN September, 1895, a paragraph appeared in a local newspaper stating that some moa-bones had been found in South Canterbury. I therefore visited the place, which was at the Kapua Settlement, near the head of Waimate Gorge. The bones had been found when sinking a well, and, after having satisfied myself by probing that there were a large number of them, I secured for the Canterbury Museum the right of digging them out. Being obliged to return to Christchurch, owing to the University session not being over, I sent Mr. W. Sparkes, taxidermist, to superintend the excavations, which he did in a most satisfactory manner, the result being the largest and most varied collection of moa-bones ever obtained from one place. The remains of carinate birds were few, and none of them belonged to still-living species.

A large number of badly-preserved and young bones were left on the ground, and of those which arrived at the Museum many were rejected as not sufficiently perfect to admit of measurement. After this was done there remained the following:—

| — | Metatarsi | Tibiæ. | Femora. | Skulls. | Sterna. | Pelves. |
|---|---|---|---|---|---|---|
| Dinornis .. .. | 124 | 99 | 100 | 7 | 80 | 24 |
| Megalapteryx .. | 8 | 1 | 1 | .. | .. | .. |
| Meionornis .. | 399 | 369 | 342 | 35 | 131 | 39 |
| Euryapteryx .. | 156 | 129 | 130 | 8 | 39 | 21 |
| Anomalopteryx .. | 4 | 2 | 5 | .. | 1 | 1 |
| Pachyornis .. | 58 | 45 | 38 | 4 | 29 | 8 |
| Total .. .. | 749 | 645 | 616 | 54 | 280 | 93 |

If we allow half as many again for the discarded bones we have a total of 1,123 metatarsi, representing probably not less than 800 birds. It will be noticed that more than half the bones belong to *Meionornis*. Next come *Euryapteryx* and *Dinornis;* while *Pachyornis* is only half as numerous as the two latter genera. This is very different from the collection I obtained for the Otago Museum from Hamilton's, where, out of 176 metatarsi, 57 belonged to *Euryapteryx*, 52 to *Pachyornis*, 32 to *Meionornis*, and 26 to *Dinornis*, the most abundant species being *Pachyornis elephantopus*.

### Mode of Occurrence of the Bones.

The hills north-west of Waimate send out a spur in a southerly direction to the Waihao River. This spur is crossed by a narrow gorge, known as the Waimate Gorge, which, after crossing the spur, opens out into a plain, about three miles long and one mile broad, at a distance of four miles from Waimate. This is the basin of a former lake, which was drained by the stream which runs through Waimate Gorge. To the north the plain is bounded by Palæozoic or Older Mesozoic hills, and on the south by a low, narrow ridge of Tertiary rocks, which separates it from the valley of the Waihao River. The plain is about 300ft. above the sea, and the valley of the Waihao is about 100ft. lower. When the settlers first came to the place the lake was not quite dry, for a small pond still remained close to its former exit, at the entrance to the gorge. This pond has been lately drained, and it was there where the bones occurred. The drain, which was 7ft. deep, did not disclose a single bone, although there are bones on both sides of it in patches. The patch dug out for the Museum was on the eastern side of the Government drain, and was on the section belonging to Mr. T. A. McDonald. The area excavated was 30ft. by 20ft., and the section was as under:—

3. Pale-yellow clay, 4ft. thick, soft and wet in places. No moa-bones.
2. Black sandy clay, 1½ft. thick, with a few moa-bones.
1. Tough blue clay, 4ft. to 5ft., full of moa-bones.

Below the patch of bones the blue-clay still continued downwards, but without any bones in it. The bones were mixed, as usual, with large quantities of moa-stones—chiefly of white quartz—of all sizes, from mere sand up to pebbles 1½in. in diameter, thus proving that the bodies of the moas were floated into the lake before decomposition. No large timber, or other evidence of floods, was found; only a few small sticks here and there. There were large numbers of bones of young moas; but no egg-shell was found, nor any land or fresh-water Mollusca.

The origin of this old lake is very obscure. There are no extinct volcanoes in the neighbourhood, and there is no evidence of the former existence of a glacier. An unequal movement of the land appears to be the most probable cause; but, be this as it may, it is evident that it was only during a portion of the lake's history that the bodies of moas were floated into it and buried in mud. It is possible, but not probable, that no moas lived near the lake before that period, but certainly they lived there afterwards, although none were buried in the lake. Consequently we must suppose that different climatic conditions prevailed during the time the moa-deposit was formed from that which followed, and, probably, from that which preceded it also. The burying of the moas was, most probably, due to floods, caused either by heavy rain or by the rapid melting of snow; and if trees were also washed into the lake they must have floated to a greater distance than the moas—perhaps out of the lake altogether. The peaty layer above the bones seems to show that the diluvial epoch was followed by a specially dry epoch, which allowed vegetable growth to accumulate on the bottom of the lake; and the dry epoch was succeeded by the present one. Evidently the bone-deposit is an old one.

## SPECIFIC CHARACTERS IN THE DINORNITHIDÆ.

Whenever we find an anatomical structure tolerably constant in the moas we nearly always find it exhibited by bones of very different sizes—so different, indeed, that we cannot suppose the two birds to which the bones belonged to have stood in the relation to each other of parent and offspring. If, therefore, the term "species" can be defined as a group of individuals which resemble each other as much as parents resemble their offspring it is evident that we have two or more species belonging to the same genus, and that the peculiar anatomical structure is of generic value. When, however, we come to look for other characters except size to distinguish between the species we generally find that the subordinate anatomical characters are so variable that they cannot be relied on for specific diagnosis, and we have therefore to fall back upon measurements of the bones. In fact, structural characters, when not of generic importance, are merely individual variations which are not transmitted. But there is often in each series a complete set of connecting links between the largest and the smallest bones, so that we feel doubtful where to draw the dividing-line. In my former paper on the moas of New Zealand* I took individual skeletons, or parts of skeletons, as guides for arranging the other bones into

* Trans. N.Z. Inst., vol. xxiv., p. 93.

species; but the present large collection—all from one place—enables me to pursue another system, and to ascertain which bones belong to different species by the method of averages. The advantage is that we thus find the commonest or most typical form of each species, while by the former method we may be taking an exceptional bird as our guide.

The result of my examination is to show that, although the species do, undoubtedly, often pass into each other, still the connecting links are comparatively rare, while the main body of the individuals of a group are well separated from the main body of individuals of another group; or, in other words, the individuals form clusters with only a few connecting links. These clusters or groups I take to be species; and this has made me abandon the following specific names formerly proposed by me, although some of them may, perhaps, have to be used in the future as varietal names: *Dinornis validus, potens*, and *strenuus*; *Palapteryx plena*; *Euryapteryx compacta*; and *Pachyornis valgus*.

The classification of the moas has been further complicated by the idea that the sexes must have been of different sizes. This idea, discussed and rejected by Sir Richard Owen,* was again brought forward by Sir Julius von Haast, and was subsequently developed by Mr. R. Lydekker. It has, however, no positive evidence in its favour, but, as Mr. Lydekker himself says, is an inference from the case of the *Apterygidæ*, in which the females are larger than the males. But the measurements which I have made of 2,010 leg-bones of the *Dinornithidæ* by no means confirm this inference; on the contrary, they show distinctly that, in several species at least, sexual differences of size are very slight, if any; and this result I take to be the most important part of my investigation. The evidence for this statement will be given in the remarks on the species, but it will save much repetition if I here give an outline of the reasoning employed.

In the first place, if the sexes of a species are of different sizes, these two sizes will be more numerous than other sizes which are individual variations from the average, and a species would consist of two groups or clusters. But we must remember that this might also be due to the existence of two varieties of different sizes, too closely connected by intermediate sizes to allow us to call them separate species.

In the second place, we may fairly assume that the sexes lived together and had the same habits. If the moas were monogamous—as are the kiwi, the emu, and the cassowary—we should expect each sex to be equally numerous. If, however, they were polygamous—as are the rhea and ostrich—

* Trans. Zool. Soc. of London, vol. iii., p. 252.

then the females would outnumber the males, but we should expect to find the same proportion between the sexes maintained in each locality. On the other hand, two varieties of a species might, very probably, have different geographical distributions or different habitats. This may enable us to distinguish between varieties and sexes, and to test the validity of supposed species.

In the third place, we may assume that if a considerable difference in size between the sexes existed in one species it existed in all belonging to the same genus; and, *vice versâ*, if there was no sexual difference of size in one species, probably there was not much difference in others. Consequently, if two different sizes of a species occur frequently, they are probably due to sexual differences; if, however, this only occurs occasionally, it is probably due to the existence of two varieties.

Another important result of these measurements is to show that of all the leg-bones the tibio-tarsus is the least variable and gives the best specific characters.

### EXPLANATION OF THE DIAGRAMS.

While a knowledge of the width at the extremities of the limb-bones is necessary for their generic determination, the specific characters chiefly depend on the length and on the width of the shaft in the middle. I have therefore drawn a set of diagrams showing both of these measurements and also the number of bones agreeing with them, these being expressed by numbers in the squares; consequently these diagrams give the length and mid-width of each of the 2,010 bones which I measured. An examination of them will show what I mean by the bones being arranged in clusters; generally with one, but occasionally with two, points of concentration within what I take to be a specific area. It will be noticed that it is only occasionally that the lines defining the species are arbitrarily drawn—usually there is a distinct indication of a break. My greatest difficulty has been to distinguish between the leg-bones of *Euryapteryx crassa* and those of *Meionornis casuarinus*. The leg-bones of these two species pass completely into each other, and in drawing the line of division I have been guided by the proportionate numbers of skulls and sterna of *Meionornis* and *Euryapteryx* respectively. Taking these as guides, I have divided the leg-bones into somewhat similar proportions; and although, doubtless, some bones of *crassa* are included in *casuarinus*, and some of the latter in *crassa*, I do not think that it affects the general results much, and it cannot invalidate the conclusions arrived at as to the average dimensions of the leg-bones in each species.

In some doubtful cases I have been guided by the proportionate numbers of the other bones of the leg. For example, the tibiæ in *Dinornis* are more easily separated into three groups than are the femora or the metatarsi, and so I have taken them as a guide for the other bones.

In my paper on the axial skeleton of the *Dinornithidæ* * I have given the generic characters of the vertebral column, pelvis, and sternum; in the present paper, therefore, I have only mentioned those of the limb-bones; and the table at the end gives the average dimensions of these bones, in millimetres, for each species.

## Genus DINORNIS.

The *femur* is distinguished by its short head and the flat internal trochanterial surface. The shaft is usually round in transverse section, but sometimes flattened from front to back. The linea aspera is broken and often not well marked. The popliteal depression is short and rather deep; the two rough tuberosities (for the heads of the gastrocnemius?) are separated by a smooth longitudinal groove. The distal intercondylar fossa is deep on the inside, shallow and broad on the outside.

The *tibia* has a length of 12 to 13 times its width in the middle of the shaft. The shaft is long and slender, often slightly curved, and its antero-outer surface is convex in the middle. The extensor bridge and its tubercle are directed above the top of the outer condyle.

The *metatarsus* has a length of more than 7 times the width in the middle. The proximal articular surface has its inner margin nearly straight and its outer margin rounded. The second trochlea is short, not much longer than the fourth, and its base is broader than that of the fourth.

None of the *scapulo-coracoids* showed any trace of a glenoid cavity, but several have a depression on the *inner* side at the anchylosis of the two bones, which might perhaps lead to a mistake. The only cases of a supposed glenoid cavity are those reported by Mr. H. O. Forbes,† and, as both these bones are in his possession, I cannot offer an opinion on them.

### Dinornis maximus.

*D. maximus* and *D. altus*, Owen.
*D. maximus* (female only), Lydekker.
*D. maximus* and *D. validus*, Hutton.

The number of leg-bones measured was—metatarsi, 30;

* Trans. N.Z. Inst., vol. xxvii., p. 157.
† *Nature*, 14th January, 1892.

tibiæ, 31; femora, 25. The femur, relatively to the tibia, is rather shorter than in the two next species, being considerably less than half its length. The diagrams show that *D. maximus* and *D. robustus* are closely connected: the separation is fairly distinct in the tibiæ, but it is not possible always to distinguish the metatarsi and femora of each. Nevertheless, as the difference in size between the typical *D. maximus* and the smaller form of *D. robustus*—called by me *D. potens*—is about one-third, we cannot suppose them to belong to a single species. Mr. Lydekker supposes that this species is the female of *D. robustus;* but the distribution of the forms is against the idea. At Glenmark and at Enfield the remains of *D. maximus* were nearly three times as numerous as those of *D. robustus.* At Kapua they were about equal, and at Hamilton *D. maximus* was not represented at all.

The metatarsi and femora show one point of concentration only, but with the tibiæ there are two, one of which has a length of 31in., the other of 33in. It is possible that these may indicate sexual differences, but more probably they are varietal. The femur varies very much in thickness, and some of those included under *D. robustus* may belong here.

The *sternum* has a breadth just below the costal border of 8·5in. to 9in.

The *pelvis* has a length of 24in.; the breadth at the antitrochanters is 10·5in.; and the depth of the pre-acetabular part of the ilium is 7·5in. to 8in.

### DINORNIS ROBUSTUS.

*D. robustus*, Owen.
*D. maximus* (male), Lydekker.
*D. robustus* and *D. potens*, Hutton.

The number of leg-bones measured was—metatarsi, 39; tibiæ, 35; femora, 40. The femur is about half the length of the tibia. The *sternum* has a width of 7in. to 8in. just below the costal border. The *pelvis* has a length of about 21in.; its width at the antitrochanters is 10in.; and the depth of the antacetabular portion of the ilium is 6·5in.

The diagrams of this species show that not only do the tibiæ concentrate on two points, with lengths of 30in. and 27in. respectively, but the femora also show a slight tendency to a double concentration. This may be due either to sexual differences or to the existence of two sub-species. If the first is the true explanation it is probable that the smaller form (*potens*) is the female, for an individual of this size was found, in 1861, at Tiger Hill, accompanied by four half-grown chicks.

DINORNIS TOROSUS.

*D. struthioides* (part), Owen.
*D. gracilis* and *D. struthioides*, Haast.
*D.* sp. (*robustus*) and *D. struthioides* (part), Lydekker.
*D. torosus*, *D. strenuus*, and *Pal. plena*, Hutton.

The number of leg-bones measured was—metatarsi, 55; tibiæ, 33; femora, 35. The *sternum* has a width of 5·5in. to 6·2in. just below the costal border. The length of the *pelvis* is about 17in.; its width at the antitrochanters 8in.; and the depth of the antacetabular portion of the ilium about 5in.

This species is well marked off from *D. robustus*, and I was evidently quite wrong in subdividing it. There are not two sizes, but each bone shows a single point of concentration. Here, therefore, we have good evidence that the two sexes were practically identical in size, and consequently it is probable that the same held good with the larger species of *Dinornis*. Certainly it does away with any argument based on the different sizes of the sexes in *Apteryx*.

## Genus MEGALAPTERYX.

The *femur* has a short head with slightly constricted neck. The shaft is slender, slightly compressed laterally in the middle, and the anterior surface is curved longitudinally in the antero-posterior plane. The linea aspera is well marked, but the popliteal tuberosities are obsolete. The popliteal depression is short and shallow. The distal intercondylar fossa is deep on the inside and shallow on the outside.

The length of the *tibia* is 12 to 14 times its width in the middle. The procnemial ridge is nearly straight. The shaft is convex both before and behind, and is more nearly oval in transverse section than in any other genus. The extremities are but slightly expanded, and the extensor bridge and tubercle are directed above the top of the outer condyle.

The length of the *metatarsus* is between 6 and 7 times the width in the middle. The proximal articular surface has both its inner and outer margins rounded. The foramina above the insertion of the tibialis anticus usually open anteriorly into a deep depression, and their posterior openings are nearer together than in other genera. The posterior surface of the shaft is more rounded than in any other genus. The trochleæ diverge strongly: the second is short, its outer surface with a deep depression, and its base markedly broader than that of the fourth. The two trochlear gorges are of about equal depth.

MEGALAPTERYX TENUIPES.

*M. tenuipes* and *M. hectori* (female), Lydekker.

Only two metatarsi and a dorsal vertebra were found. The dimensions of the best-preserved metatarsus are given in the table; the other was smaller, having a length of 185mm.

MEGALAPTERYX HECTORI.

*M. hectori*, Haast.
*M. hectori* (male), Lydekker.

Of this species there was one complete and well-preserved leg, the dimensions of which are given in the table. It is larger than the type, but has the same slim character; while *M. tenuipes* is stouter, and has a relatively shorter metatarsus. The perforation in the groove between the third and fourth metatarsal bones, which is given by Sir Julius von Haast as a generic character, is not constant.

## Genus MEIONORNIS.

In the *femur* the head is moderately long and the neck much constricted below. The internal trochanterial surface is deeply concave, sometimes even excavated. The shaft is slender and rounded in transverse section; the linea aspera is well marked, rarely broken. The popliteal depression is short and rather shallow; the two tuberosities are confluent and situated at the apex of the depression. The distal intercondylar fossa is deep on the inside, variable on the outside.

The length of the *tibia* is 10 to 12 times its mid-width. The shaft is slender and straight; its antero-outer surface flattened in the middle. The distal extremity is moderately expanded inwards; the bridge and tubercle directed towards the inner condyle.

The *metatarsus* has a length of 4 to 5 times its mid-width. The proximal articular surface has the inner margin ridged in the middle. The proximal interosteal foramina open anteriorly into a deep depression, on the inner margin of which there is a small rough tubercle. There is often a distal interosteal foramen in the groove between the second and third metatarsal bones, and occasionally one between the third and the fourth. The trochleæ do not diverge very widely: the second is longer than in the other genera; its outer surface has only a shallow depression, and its base is narrower than that of the fourth. The gorge between the second and the third is not so deep as that between the third and the fourth.

### Meionornis casuarinus.

*Dinornis casuarinus* and *D. rheides*, Owen.
*Meionornis casuarinus*, Haast.*
*Anomalopteryx casuarina*, Lydekker.
*Syornis casuarinus* and *S. rheides*, Hutton.

The number of leg-bones measured was—metatarsi, 327; tibiæ, 301; femora, 276. The *sternum* has a width below the costal border of 5·2in. to 6·8in. The *pelvis* has a length of 16in. to 18·5in.; the width at the antitrochanters is 8in. to 9·7in.; and the depth of the pre-acetabular portion of the ilium is 4·7in. to 5in.

I have already explained that the line drawn between the leg-bones of this species and those of *E. crassa* is artificial, as the two overlap. The large number of bones of this species proves clearly that there are not two sizes, for there is only a single point of concentration in each bone.

If the metatarsus is the type of *D. rheides*, then it is the largest form of *M. casuarinus*. In all probability the skull with neck in the Wellington Museum, referred to by Professor Parker as *Mesopteryx*, sp. *b*,† belongs to it, and perhaps, therefore, we should be justified in considering it as a good species, for the skull seems sufficiently distinct.

### Meionornis didinus.

*Dinornis huttonii* and *D. didinus*, Owen.
*Meionornis didiformis*, Haast.
*Anomalopteryx didiformis* (part) and *A. didina*, Lydekker.
*Mesopteryx didina*, Hutton.

The number of leg-bones measured was—metatarsi, 72; tibiæ, 68, femora, 66. The width of the *sternum* below the costal border is 4in. to 4·5in. The length of the *pelvis* is about 15·5in.; and its width at the antitrochanters is about 7in.

Here, again, we have only a single point of concentration in each bone, showing that there was no difference in size between the sexes. The tibia is well marked off from that of *M. casuarinus*, but the other two bones show many intermediate varieties. However, *M. didinus* is distinguished from *M. casuarinus* by its relatively longer metatarsus. The two cannot be different sexes of one species, because their distribution is so different. At Enfield, *M. didinus* was far more

* In *Euryapteryx rheides*, Haast, the metatarsi alone belong to *D. rheides*; the rest of the skeleton is partly *M. didinus* and partly *P. inhabilis*.

† Trans. N.Z. Inst., vol. xxv., p. 4, pl. 1.

abundant than *M. casuarinus*, while exactly the opposite was the case at Hamilton, Kapua, and Glenmark. Moreover, bones of *M. didinus* were common in the cave at Castle Rock, Southland, explored by Mr. A. Hamilton,* while *M. casuarinus* was not even represented. It is therefore almost impossible that they could have been male and female of one species.

## Genus EURYAPTERYX.

In the *femur* the head is long and rises nearly as high as the trochanter; the neck is slightly constricted below. The internal trochanterial surface is concave or excavated. The shaft is very variable in shape, usually flattened from front to back, but sometimes it is laterally compressed; the linea aspera is not well defined. The popliteal depression is moderate, the two tuberosities confluent or nearly so, chiefly situated at the apex of the depression. The distal extremity is much expanded, and the intercondylar fossa is very deep on both sides. The following characters distinguish it from the femur of *Meionornis:* The head is longer and rises more rapidly, the anterior surface of the shaft is flatter, and the distal end is more expanded.

The length of the *tibia* is between 8¾ and 11 times the width of the shaft in the middle. The shaft is straight and stout, the proximal posterior surface concave; the antero-outer surface flattened in the middle. The distal extremity is less expanded inwards than in *Pachyornis*, and is nearly always less than 3·3in. in width.

The length of the *metatarsus* is between 3¾ and 4¾ times the width of the shaft in the middle, which is nearly the same in all three bones of the leg. The proximal articular surface has the inner margin nearly straight (except in *crassa*). The proximal interosteal foramina open anteriorly into a deep depression, on the inner margin of which there is usually a rough tubercle. The trochleæ diverge moderately; the second is long, with a shallow depression on the outer surface, its base is narrower than that of the fourth, but its anterior surface is as broad as that of the third, which does not project forward so much as in *Pachyornis*.

In the Dunedin Museum there are two complete feet of *E. gravis*, and in the Christchurch Museum there is a complete foot of *E. ponderosa* and another of *E. crassa*, all obtained from the sandhills at Shag Point. In all these there are only four phalanges in the outer toe, so that this must be considered the normal number in the genus.

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* Trans. N.Z. Inst., vol. xxv., p. 102.

### Euryapteryx crassa.

*Dinornis crassus*, Owen.
*Emeus crassus*, Lydekker.
*Syornis crassus*, Hutton (not *Palapteryx crassus*, Haast).

The number of leg-bones measured was—metatarsi, 108; tibiæ, 99; femora, 101. This species, although so difficult to disentangle from *M. casuarinus*, is distinguished by its greater robustness, and by having a shorter tibia but longer femur. Here again the diagrams show only one point of concentration for each bone, so that there could not have been a difference in size between the sexes.

The width of the *sternum* below the costal border is about 5·8in., and the length of the body is 5in. The length of the *pelvis* is 16in. to 17·5in., and its width at the antitrochanters is 8·5in. to 9in.

### Euryapteryx ponderosa.

*Palapteryx elephantopus* (part), Haast.
*Emeus*, sp. *a*, Lydekker.
*Euryapteryx ponderosa* and *E. elephantopus* (part), Hutton.

The number of leg-bones measured was—metatarsi, 25; tibiæ, 15; femora, 23. The width of the *sternum* below the costal border is 6in. to 6·5in., and the length of the body 4·5in. to 4·7in. The length of the *pelvis* is 18in. to 19in., and its width at the antitrochanters is 10·5in. to 11·5in.; the depth of the antacetabular part of the ilium is 5in. to 6in.

The diagrams show a single point of concentration in the metatarsi and tibiæ, but the femora are diffused. The leg-bones differ from those of *E. crassa* more in thickness than in length, but as a species it is well marked off, especially by its relatively longer and stouter tibia.

### Euryapteryx gravis.

*Dinornis gravis*, Owen.
*Euryapteryx gravis*, Haast.
*Emeus gravipes*, Lydekker.
*Euryapteryx gravis* and *E. compacta*, Hutton.

The number of leg-bones measured was—metatarsi, 28; tibiæ, 12; femora, 16. The width of the *sternum* below the costal border is about 5in., and the length of the body 4in. The length of the *pelvis* is about 14·5in., and its width at the antitrochanters is 7in. to 8in.

In this species none of the bones show a decided concentration. It is very closely allied to *E. crassa*, the limb-bones having the same proportionate lengths, but it is smaller,

and the femur and metatarsus are proportionately stouter. Also, there is often a transverse depression on the anterior surface of the metatarsus at the base of the fourth trochlea, which seems to imply some peculiar habit.* The skull is shorter and flatter than that of *E. crassa*, and usually the temporal fossæ are deeper.

## Genus ANOMALOPTERYX.

In the *femur* the head is moderate in length and the neck is well marked. The internal trochanterial surface is slightly concave. The shaft is slender, and slightly curved longitudinally on the anterior surface; the linea aspera indistinct. The popliteal depression is long, and very shallow; the two tuberosities are but slightly developed.

The length of the *tibia* is from 12 to 13 times its width in the middle. The shaft is straight, and the antero-outer surface slightly convex. The distal extremity is moderately expanded inward; the extensor bridge and tubercle are directed above the outer condyle.

The length of the *metatarsus* is from 5 to 6 times its width in the middle. The proximal articular surface has its inner margin flat or concave. The proximal interosteal foramina open separately on the anterior surface, or into a shallow depression. Usually the trochleæ do not diverge so strongly as in *Megalapteryx*, but this differs in different species. The second trochlea is not so long as in *Meionornis*, and its base is not so broad as in *Megalapteryx*. Usually there is a depression at the base of the anterior surface of the third trochlea, but this sometimes occurs also in *Meionornis*.

### ANOMALOPTERYX FORTIS.

*Anomalopteryx fortis*, Hutton.

The bones belonging to this species were four metatarsi, two tibiæ, five femora, a sternum, and a pelvis. Of the *metatarsi*, the largest has a length of 8in. and a mid-width of 1·4in.; the smallest is 7·3in. long, with a mid-width of 1·3in. In both of them the proximal width was 2·3in., and the distal width 3in.

Of the *tibiæ*, the largest was 16·5in. in length, 1·3in. in width at the middle of the shaft, and 2·1in. at the distal end. The smallest was 15·8in. long, with a mid-width of 1·3in. and a distal width of 2in.

Of the *femora*, the largest was 10·2in. long and the smallest was 9·6in.; in both the mid-width was 1·3in. and the distal width 3·3in.

* This occurs also in *Anomalopteryx fortis*.

The *sternum* has distinct, but round and shallow, coracoidal pits, very different from those of *A. parva*. The width below the costal border is 3·7in., and the length of the body is 3·5in.

The *pelvis* has a length of 15·7in., and its width at the antitrochanters is 7·5in.; the depth of the pre-acetabular portion of the ilium is 3·7in. It is relatively broader than the pelvis of *A. parva*, but resembles it in other respects. From the pelvis of *M. didinus* it can be distinguished by the compressed centra of the pre-sacral vertebræ, and by the greater length of the mass of sacral vertebræ (numbers 35–37), which have no transverse processes.

As *A. fortis* is a species not mixed, either at Kapua or at Glenmark, with any other of the same genus, it will perhaps give us some idea of the amount of variation in size in the different species of moas. I find that the metatarsus varies about $\frac{1}{8}$ in length and $\frac{1}{7}$ in mid-width. The tibia varies $\frac{1}{8}$ in length and $\frac{1}{14}$ in mid-width. The femur varies $\frac{1}{9}$ in length and $\frac{1}{14}$ in mid-width. In the metatarsus both the distal and the proximal width vary about $\frac{1}{8}$; but in the tibia and in the femur the distal width is the most constant element, the variation being only $\frac{1}{30}$ and $\frac{1}{17}$ respectively. It thus appears that the metatarsus is the most variable bone.

## Genus PACHYORNIS.

In the *femur* the head is rather short, the neck thick and but slightly constricted. The internal trochanterial surface is flat, or slightly concave. The transverse section of the shaft is usually oval, but it is variable. The linea aspera is broken and not well marked. The popliteal depression is short and deep; the two tuberosities are usually separated, and the inner one placed on the inner margin of the popliteal depression. The distal extremity is much expanded; the intercondylar fossa nearly as deep on the outer as on the inner side. From the femur of *Euryapteryx* it may be distinguished by the shorter and thicker head, and by the internal trochanterial surface being flatter.

The length of the *tibia* is between $7\frac{1}{2}$ and 11 times that of the width of the shaft in the middle. The shaft is usually straight, but sometimes it is considerably curved inward; its antero-outer surface is usually convex (flat in *P. immanis*). The distal extremity is much expanded inward, and the distal width is almost always more than 3·3in. The extensor bridge and its tubercle are directed at the outer condyle.

The length of the *metatarsus* is from 3 to $4\frac{1}{2}$ times that of its mid-width, which is always greater than that of the tibia or femur. The proximal articular surface has the inner margin

sinuated. The proximal interosseous foramina either open separately on the anterior surface, or into a shallow depression situated above the insertion of the tibialis anticus, and there is no rough tubercle on the inner margin of this depression. The trochleæ are much expanded, and the third projects forward more than in any other species.

The differences between the species depend more on the thickness than on the length of the leg-bones.

### PACHYORNIS IMMANIS.

*Palapteryx elephantopus* (part), Haast.
*Dinornis elephantopus*, var. *major*, Hutton.
*Pachyornis immanis*, Lydekker.

The number of leg-bones measured was—metatarsi, 18; tibiæ, 7; femora, 9. I cannot distinguish the sternum and pelvis of this species from those of *P. elephantopus*.

The diagrams show that, while the metatarsi are diffused, the tibiæ and femora tend slightly to concentrate on two points far apart. In the larger form the shaft of the tibia is much curved inwards, but it is nearly straight in the smaller form. This looks as if the species ought to be broken up into two, but the remains are too few to enable me to do so with confidence. In the metatarsus the proximal interosteal foramina always open separately on the anterior surface, and there is no depression above the insertion of the tibialis anticus; but this does not hold good for bones from other localities.

It is impossible to distinguish accurately between the metatarsi of this species and *P. elephantopus*, but the axial skeleton shows many differences.

### PACHYORNIS ELEPHANTOPUS.

*Dinornis elephantopus*, Owen.
*Palapteryx elephantopus* (part), Haast.
*Pachyornis elephantopus*, Lydekker.
*Euryapteryx elephantopus* (part), Hutton.

The number of leg-bones measured was—metatarsi, 37; tibiæ, 30; femora, 25. The width of the *sternum* below the costal border is 7in. to 8in. The *pelvis* has a length of about 20in., and its width at the antitrochanters is about 10·8in.

Concentration is fairly well marked in the metatarsi and femora, but not in the tibia, which is unusual. In the metatarsus the proximal foramina open either separately on the anterior surface, or sometimes into a depression. The shaft of the tibia is nearly always straight, and its antero-outer surface is convex.

### Pachyornis inhabilis.

*Pachyornis*, sp. *a*, Lydekker.
*Pachyornis inhabilis* and *P. valgus*, Hutton.

The number of leg-bones measured was—metatarsi, 8; tibiæ, 8; femora, 4. The *sternum* has a width of 6in. to 6·5in. below the costal border. The *pelvis* has a length of from 17in. to 20in., and its width at the antitrochanters is 9in. to 9·7in.

This species is more slender than *P. elephantopus*, and does not attain to so large a size; the skull also is different; but the two are closely connected. In the metatarsus the proximal interosteal foramina always open into a depression above the insertion of the tibialis anticus.

## CARINATE BIRDS.

*Harpagornis assimilis*, Haast.—One tibia only.
*Nestor*, sp. ind. — One cranium, smaller than any living species.
*Fulica prisca*, Hamilton.—Two broken tibiæ.
*Aptornis bulleri*, Owen (Buller's "Birds of New Zealand," Introduction, p. xxiii.).—A cranium, a pelvis, two femora, two tibiæ, a metatarsus, and two vertebræ, equal in size to *A. defossor*.
*Notornis*, sp.—One metatarsus.
*Cnemiornis calcitrans*, Owen.—A cranium and a pelvis.

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### LEG-BONES FROM KAPUA.

Average Measurements, in Millimetres.

| — | Metatarsus. | | | | Tibia. | | | | Femur. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length. | Proximal Width. | Middle Width. | Distal Width. | Length. | Proximal Width. | Middle Width. | Distal Width. | Length. | Proximal Width. | Middle Width. | Distal Width. |
| Dinornis maximus .. | 453 | 117 | 58 | 160 | 888 | 185 | 63 | 107 | 399 | 142 | 68 | 152 |
| " robustus .. | 394 | 107 | 58 | 145 | 775 | 167 | 58 | 96 | 368 | 132 | 61 | 142 |
| " torosus .. | 305 | 89 | 40 | 128 | 584 | 132 | 43 | 79 | 292 | 114 | 46 | 124 |
| Megalapteryx tenuipes .. | 200 | 60 | 33 | 79 | .. | .. | .. | .. | .. | .. | .. | .. |
| " hectori .. | 158 | 46 | 23 | 68 | 343 | 71 | 28 | 31 | 211 | 68 | 28 | 68 |
| Meionornis casuarinus .. | 216 | 76 | 46 | 102 | 483 | 140 | 46 | 66 | 279 | 102 | 48 | 119 |
| " didinus .. | 190 | 68 | 38 | 87 | 380 | 108 | 35 | 56 | 241 | 86 | 35 | 99 |
| Euryapteryx ponderosa .. | 228 | 96 | 61 | 124 | 520 | 157 | 56 | 84 | 292 | 119 | 58 | 140 |
| " crassa .. | 220 | 81 | 48 | 107 | 475 | 137 | 46 | 71 | 287 | 109 | 46 | 124 |
| " gravis .. | 191 | 77 | 48 | 101 | 419 | 127 | 48 | 68 | 254 | 99 | 46 | 117 |
| Anamalopteryx fortis .. | 197 | 57 | 35 | 76 | 406 | 101 | 32 | 58 | 259 | 78 | 33 | 84 |
| Pachyornis immanis .. | 222 | 106 | 66 | 187 | 508 | 178 | 61 | 94 | 305 | 127 | 61 | 152 |
| " elephantopus .. | 228 | 104 | 61 | 184 | 569 | 178 | 58 | 91 | 317 | 119 | 58 | 148 |
| " inhabilis .. | 217 | 91 | 53 | 119 | 508 | 152 | 46 | 86 | 294 | 109 | 48 | 140 |

## LEG-BONES FROM KAPUA.

### DINORNIS.

| — | Length. | Mid-width of Shaft in Inches. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2·9 | 2·8 | 2·7 | 2·6 | 2·5 | 2·4 | 2·3 | 2·2 | 2·1 | 2·0 | 1·9 | 1·8 | 1·7 | 1·6 | 1·5 |
| Tibia. | 35 | 1*a* | .. | .. | .. | 1*a* | .. | 1*a* | .. | .. | .. | .. | .. | .. | .. | .. |
| | 34 | 1*a* | .. | 2*a* | .. | 3*a* | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 33 | .. | .. | .. | 4*a* | 5*a* | 2*a* | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 32 | .. | .. | .. | 2*a* | 3*a* | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 31 | .. | .. | .. | .. | 5*a* | 1*a* | 1*b* | 1*b* | 1*b* | .. | .. | .. | .. | .. | .. |
| | 30 | .. | .. | .. | .. | .. | 2*b* | 6*b* | .. | 1*b* | 1*b* | .. | .. | .. | .. | .. |
| | 29 | .. | .. | .. | .. | 2*b* | 1*b* | 2*b* | .. | 1*b* | .. | .. | .. | .. | .. | .. |
| | 28 | .. | .. | .. | .. | 2*b* | 1*b* | .. | 1*b* | 1*b* | 1*b* | .. | .. | .. | .. | .. |
| | 27 | .. | .. | .. | .. | .. | .. | .. | 1*b* | .. | 4*b* | 1*b* | .. | .. | .. | .. |
| | 26 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*b* | 2*b* | .. | .. | .. | .. |
| | 25 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 1*c* | .. | .. | .. |
| | 24 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 1*c* | 1*c* | 5*c* | .. | .. |
| | 23 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 7*c* | 5*c* | .. | .. |
| | 22 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3*c* | 2*c* | .. | .. |
| | 21 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3*c* | .. | 1*c* | .. |
| Femur. | 16 | 1*a* | 1*a* | 2*a* | 6*a* | 6*a* | 6*a* | 2*a* | 1*a* | .. | .. | .. | .. | .. | .. | .. |
| | 15 | .. | .. | .. | 2*b* | 4*b* | 6*b* | 1*b* | .. | .. | .. | .. | .. | .. | .. | .. |
| | 14 | .. | .. | .. | 1*b* | 4*b* | 6*b* | 4*b* | 2*b* | 1*b* | 1*b* | .. | .. | .. | .. | .. |
| | 13 | .. | .. | .. | .. | .. | .. | 3*b* | .. | 3*b* | 1*b* | 1*c* | .. | .. | .. | .. |
| | 12 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 6*c* | 5*c* | 7*c* | 1*c* | .. |
| | 11 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 2*c* | 6*c* | 5*c* | 1*c* | .. |
| Metatarsus. | 19 | .. | .. | .. | .. | .. | 2*a* | 2*a* | .. | .. | 2*a* | .. | .. | .. | .. | .. |
| | 18 | .. | .. | .. | 1*a* | .. | 4*a* | 7*a* | 5*a* | 1*a* | .. | .. | .. | .. | .. | .. |
| | 17 | .. | .. | .. | .. | .. | .. | 2*a* | 1*a* | 3*a* | .. | .. | .. | .. | .. | .. |
| | 16 | .. | .. | .. | .. | .. | .. | .. | 9*b* | 4*b* | 3*b* | .. | .. | .. | .. | .. |
| | 15 | .. | .. | .. | .. | .. | .. | .. | .. | 1*b* | 4*b* | 4*b* | 2*b* | .. | .. | .. |
| | 14 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*b* | 2*b* | 1*b* | 3*b* | .. | .. |
| | 13 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2*c* | 1*c* | 1*c* | 1*c* | 2*c* |
| | 12 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 3*c* | 3*c* | 19*c* | 9*c* |
| | 11 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 7*c* |

*a*. Dinornis maximus.
*b*. „ robustus.
*c*. „ torosus.

## LEG-BONES FROM EURY

| Length. | 3·0 | 2·9 | 2·8 | 2·7 | 2·6 | 2·5 | 2·4 | 2·3 | 2·2 | 2·1 | 2·0 | 1·9 | 1·8 | 1·7 | 1·6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mid-width of Shaft in Inches. | | | | | | | | | | | | | | | |
| 23·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1b | .. | .. | .. | .. | Tibia. |
| 22·5 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2b | 1b | .. | .. | .. | .. | |
| 22·0 | .. | .. | .. | 1a | 1a | 1a | .. | .. | 6b | 3b | 4b | .. | .. | .. | .. | |
| 21·5 | .. | .. | .. | .. | .. | .. | .. | .. | 3b | .. | .. | .. | .. | .. | .. | |
| 21·0 | .. | .. | .. | .. | .. | .. | 1a | .. | .. | .. | .. | .. | 1c | .. | .. | |
| 20·5 | .. | .. | .. | .. | .. | .. | .. | 1a | 1b | 4b | .. | 2c | .. | .. | .. | |
| 20·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2b | 1c | 1c | .. | .. | |
| 19·5 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1c | .. | .. | .. | |
| 19·0 | .. | .. | .. | .. | .. | .. | .. | . | .. | 2b | 1b | 1c | .. | .. | .. | |
| 18·5 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1c | |
| 18·0 | .. | .. | .. | .. | .. | .. | .. | 2a | .. | .. | .. | .. | .. | .. | .. | |
| 13·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1b | 2b | .. | .. | .. | .. | Femur. |
| 12·5 | .. | .. | .. | 1a | 1a | .. | 2a | 1b | 6b | 5b | 3b | .. | .. | .. | .. | |
| 12·0 | .. | .. | .. | .. | .. | 1a | .. | .. | 1b | 3b | 2b | 2c | .. | .. | .. | |
| 11·5 | .. | .. | .. | .. | .. | .. | .. | 1a | .. | 1b | 1c | .. | .. | .. | .. | |
| 11·0 | .. | .. | .. | .. | .. | .. | .. | .. | 1a | 2a | 1c | .. | .. | .. | .. | |
| 10·0 | .. | .. | .. | .. | 1b | 2b | .. | .. | .. | .. | .. | .. | .. | .. | .. | Metatarsus. |
| 9·5 | 1a | .. | 1a | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | |
| 9·0 | 1a | .. | 1a | 3a | 2a | 3b | 5b | 3b | 2b | 2c | .. | .. | .. | .. | .. | |
| 8·5 | .. | .. | .. | 1a | 1a | 3a | 4b | 7b | 4b | 3c | 2c | .. | .. | .. | .. | |
| 8·0 | .. | .. | .. | .. | .. | 3a | 1a | 1b | 2b | 1c | .. | .. | .. | .. | .. | |

a.
b.
c.

| Length. | 2·4 | 2·3 | 2·2 | 2·1 | 2·0 | 1·9 | 1·8 | 1·7 | 1·6 | 1·5 | 1·4 | 1·3 | 1·2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mid-width of Shaft in Inches. | | | | | | | | | | | | | |
| 21·5 | .. | .. | 1e | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | Tibia. |
| 21·0 | 1e | .. | 6e | .. | 1f | .. | .. | .. | .. | .. | .. | . | .. | |
| 20·5 | .. | 2e | 1e | 1e | 2f | .. | 1h | .. | .. | .. | .. | .. | .. | |
| 20·0 | .. | .. | .. | 2e | 5f | 5f | 4h | 4h | .. | .. | .. | .. | .. | |
| 19·5 | .. | 1e | .. | .. | .. | 7f | 33h | 8h | .. | .. | .. | .. | .. | |
| 19·0 | .. | .. | .. | .. | 3f | 15f | 58h | 27h | 11h | .. | .. | .. | .. | |
| 18·5 | .. | .. | .. | .. | 2f | 3f | 39f | 27h | 11h | .. | .. | .. | .. | |
| 18·0 | .. | .. | .. | .. | .. | 2f | 11f | 27h | 9h | .. | .. | .. | .. | |
| 17·5 | .. | .. | .. | .. | .. | .. | 4f | 29h | 21h | 1h | .. | .. | .. | |
| 17·0 | .. | .. | .. | .. | .. | .. | 4g | 5g | 16h | 1h | .. | .. | .. | |
| 16·5 | .. | .. | .. | .. | .. | .. | .. | 3g | 9h | 4h | .. | .. | .. | |
| 16·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 4i | 2i | .. | .. | |
| 15·5 | .. | .. | .. | .. | .. | .. | .. | .. | 2i | 8i | 7i | 3i | .. | |
| 15·0 | .. | .. | .. | .. | .. | .. | .. | .. | 1i | 14i | 17i | 3i | .. | |
| 14·5 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2i | 5i | .. | |
| 12·0 | .. | 3e | 2e | 5e | 2f | .. | 7f | 1h | 1h | .. | .. | .. | .. | Femur. |
| 11·5 | .. | 3e | 5e | 4e | 5f | 7f | 34f | 36h | 14h | 1h | .. | .. | .. | |
| 11·0 | .. | .. | 1e | .. | 6f | 4f | 27f | 62h | 59h | 10h | .. | .. | .. | |
| 10·5 | .. | .. | .. | .. | .. | 3g | 9f | 29h | 42h | 22h | 2h | .. | .. | |
| 10·0 | .. | .. | .. | .. | 1g | 1g | 4g | .. | 7h | 10i | 6i | .. | .. | |
| 9·5 | .. | .. | .. | .. | .. | 1g | .. | 6g | .. | 14i | 14i | 7i | 1i | |
| 9·0 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1i | 8i | 4i | 1i | |
| 9·5 | 3e | 5e | 1e | .. | 3f | 2f | .. | .. | .. | .. | .. | .. | .. | Metatarsus. |
| 9·0 | 11e | 2e | 2e | 2f | 10f | 19f | 27h | 5h | 1h | .. | .. | .. | .. | |
| 8·5 | .. | .. | 1e | 1f | 19f | 40f | 114h | 35h | 6h | .. | .. | .. | .. | |
| 8·0 | .. | .. | .. | 2g | 8g | 12f | 51h | 47h | 18h | 3i | 1i | .. | .. | |
| 7·5 | .. | .. | .. | .. | 1g | 5g | 7g | 8h | 15i | 31i | 5i | .. | .. | |
| 7·0 | .. | .. | .. | .. | .. | .. | .. | .. | 5i | 17i | 8i | 1i | 1i | |

# ART. LXVI.—*On the Moa-bones from Enfield.*

By Captain F. W. HUTTON, F.R.S., Curator of the Canterbury Museum, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 7th August, 1895.*]

THE mode of occurrence of the bones found in August, 1891, at Enfield, near Oamaru, has already been described by Dr. H. O. Forbes in *Nature* for March, 1892. They were imbedded in peat in a small swampy gully which runs across a field to join a stream which falls into the Waireka River. In the winter of 1891 Mr. Meek, the owner, determined to bring this swampy gully into cultivation, and the bones were found when ploughing it.

In addition to the moas, bones of several carinate birds were found, mention of which is made by Dr. Forbes in the paper already referred to, and also in the Trans. N.Z. Inst., vol. xxiv., p. 188, &c. These remains were taken to England by Dr. Forbes, and I am not aware of any description having been published of them.

In June, 1892, I made a preliminary examination of the moa-bones remaining in the Museum, as I had, at once, to make up some exchanges promised by my predecessor, and I read a paper to the Institute giving the results of that examination, at the same time saying that it was far from completed.* Since then I have had time to measure and compare all the bones in the collection, and I wish to place on record the results of my measurements, so that they can be compared with those of the bones at Kapua. It will be seen that there are many points of difference between the bones of the two localities; and this might have been expected. If the different species of moas have been gradually developed, their sizes must have differed at different periods; and, as there are geological reasons for thinking that the Enfield bones are of a later date than those from Kapua, it follows that the differences probably show the directions in which the species developed during the interval.

After rejecting bones of young birds and others which were too imperfect for measurement, I had 1,031 leg-bones left, made up as follows:—

* "New Species of Moas": Trans. N.Z. Inst., vol. xxv., p. 6.

| — | Metatarsi. | Tibiæ. | Femora. | Skulls. | Sterna. | Pelves. |
|---|---|---|---|---|---|---|
| Dinornis .. .. | 34 | 17 | 23 | 5 | 4 | 6 |
| Meionornis .. | 193 | 200 | 200 | 52 | 34 | 21 |
| Euryapteryx .. | 94 | 43 | 106 | 8 | 5 | 6 |
| Pachyornis .. | 47 | 36 | 38 | 9 | 2 | 2 |
| Totals .. | 368 | 296 | 367 | 74 | 45 | 35 |

The chief characteristic of the collection is the great number of bones of *Meionornis didinus*, one-third of the whole belonging to that species.

*Dinornis maximus.*

Metatarsi, 11; tibiæ, 7; femora, 5; may be referred to this species. The largest metatarsus was 19·5in. in length, with a width of 2·5in. at the middle of the shaft; but there was no tibia nor femur to match it. Indeed, the femora appear to be smaller than those from Kapua, but the number is too few to base any well-founded opinion on.

*Dinornis robustus.*

Metatarsi, 4; tibiæ, 3; femora, 3. These bones are too few to base any conclusions on; but it does not appear to have been clearly marked off from the last species.

*Dinornis torosus.*

Metatarsi, 19; tibiæ, 7; femora, 15. This species is very distinct from the last—more so even than at Kapua. The number of bones is not large; but they show a concentration round a single focus with each bone, and no separation into two sizes which might belong to the two sexes. This is a satisfactory corroboration of the result arrived at by an examination of the Kapua bones, and ought to set the question of the different sizes of the sexes in *Dinornis* at rest for ever.

*Meionornis casuarinus.*

Metatarsi, 74; tibiæ, 64; femora, 78. The same difficulty exists as at Kapua in separating the leg-bones of this species from those of *E. crassa*. The metatarsus is the same size as at Kapua, but the tibia and femur are rather larger. The numbers are, I think, quite sufficient to establish this point satisfactorily.

*Meionornis didinus.*

Metatarsi, 119; tibiæ, 136; femora, 122. The tibia is very well separated, and the other two bones, although showing

connecting-links with *M. casuarinus*, have well-marked concentration foci of their own, showing clearly that it is distinct from that species. Compared with the same species from Kapua, the metatarsus and the femur are the same, but the tibia is distinctly larger. There can be no hesitation in accepting this result, as the data are ample.

In my former paper, already referred to, I placed a few bones doubtfully under the name of *P. pygmæus*. These, however, do not belong to *Pachyornis*, but lie on the borderland between *M. didinus* and *E. gravis*. On the whole, I have concluded that they are a variety of the former, and I have included them here. They consist of—metatarsi, 5; tibiæ, 4; femora, 4. Possibly they are hybrids between the two species.

*Euryapteryx crassa.*

Metatarsi, 58; tibiæ, 17; femora, 68. This species was, comparatively, less numerous than at Kapua. The tibia is larger, but the metatarsus and femur are the same.

*Euryapteryx ponderosa.*

Metatarsi, 16; tibiæ, 14; femora, 28. These numbers are too small to give any results of value, but the bird appears to have been rather smaller and more slender than at Kapua.

*Euryapteryx gravis.*

Metatarsi, 20; tibiæ, 12; femora, 10. So far as these numbers allow us to form an opinion, it would seem that the tibia is considerably larger, while the femur is slightly smaller.

*Pachyornis immanis.*

Metatarsi, 7; tibiæ, 4; femora, 7. The numbers are small. The tibiæ are all of large size, and none of them shows the curvature of the shaft which is so remarkable in the bones from Kapua and Hamilton. Two of the femora are larger than any found at Kapua. The average is larger because no small bones were found.

*Pachyornis elephantopus.*

Metatarsi, 21; tibiæ, 17; femora, 15. There is in this species a most remarkable development in length without the great thickness characteristic of *P. immanis*. The metatarsi reach a length of 267mm.; the tibiæ, 622mm.; and the femora, 368mm., which are considerably greater than the largest from Kapua. The average, however, is smaller.

### *Pachyornis inhabilis.*

Metatarsi, 19; tibiæ, 15; femora, 16. This species is far better represented than at Kapua—its numbers being nearly equal to those of *P. elephantopus*—and it appears to be distinctly smaller. However, it must be remembered that the bones found at Kapua were too few in number to afford a reliable comparison. The following are the measurements of the smallest specimen:—

| — | Length. | Proximal Width. | Middle Width. | Distal Width. |
|---|---|---|---|---|
| Metatarsus .. .. .. | 185 | 81 | 48 | 106 |
| Tibia .. .. .. .. | 431 | 137 | 38 | 66 |
| Femur .. .. .. .. | 270 | 99 | 40 | 117 |

All the bones, especially the metatarsus, are well marked off from those of *P. elephantopus*.

## LEG-BONES FROM ENFIELD.

AVERAGE MEASUREMENTS, IN MILLIMETRES.

| — | Metatarsus. | | | | Tibia. | | | | Femur. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length. | Proximal Width. | Middle Width. | Distal Width. | Length. | Proximal Width. | Middle Width. | Distal Width. | Length. | Proximal Width. | Middle Width. | Distal Width. |
| Dinornis maximus .. | 457 | 122 | 55 | 165 | 800 | 165 | 68 | 119 | 394 | 152 | 60 | 165 |
| „ robustus .. | 419 | 119 | 53 | 147 | 786 | 152 | 58 | 106 | 345 | 140 | 58 | 152 |
| „ torosus .. | 305 | 91 | 40 | 119 | 610 | 147 | 48 | 84 | 305 | 107 | 48 | 122 |
| Meionornis casuarinus .. | 215 | 81 | 46 | 96 | 490 | 134 | 44 | 71 | 286 | 106 | 48 | 120 |
| „ didinus .. | 190 | 68 | 38 | 86 | 400 | 109 | 37 | 58 | 240 | 86 | 35 | 95 |
| Euryapteryx ponderosa .. | 222 | 94 | 55 | 109 | 508 | 157 | 58 | 79 | 292 | 119 | 50 | 134 |
| „ crassa .. | 216 | 84 | 49 | 106 | 482 | 142 | 48 | 71 | 285 | 110 | 47 | 127 |
| „ gravis .. | 190 | 76 | 46 | 96 | 444 | 134 | 44 | 70 | 247 | 102 | 44 | 104 |
| Pachyornis immanis .. | 241 | 110 | 66 | 138 | 584 | 180 | 60 | 94 | 320 | 134 | 60 | 160 |
| „ elephantopus | 228 | 94 | 58 | 122 | 538 | 146 | 50 | 76 | 305 | 127 | 58 | 147 |
| „ inhabilis .. | 203 | 86 | 52 | 112 | 480 | 140 | 44 | 76 | 280 | 104 | 50 | 124 |

## LEG-BONES FROM ENFIELD.

### DINORNIS.

| | Length. | Mid-width of Shaft in Inches. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2·6 | 2·5 | 2·4 | 2·3 | 2·2 | 2·1 | 2·0 | 1·9 | 1·8 | 1·7 | 1·6 | 1·5 | 1·4 |
| Tibia. | 33 | .. | 2*a* | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 32 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 31 | .. | 3*a* | .. | 2*a* | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 30 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 29 | .. | .. | 1*b* | 1*b* | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 28 | .. | .. | .. | .. | .. | 1*b* | .. | .. | .. | .. | .. | .. | .. |
| | 27 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 26 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 25 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | .. | .. | .. |
| | 24 | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 4*c* | .. | .. | .. |
| | 23 | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | .. | .. | .. | .. |
| Femur. | 16 | .. | .. | 1*a* | 1*a* | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 15 | .. | .. | 2*a* | .. | 1*a* | .. | .. | .. | .. | .. | .. | .. | .. |
| | 14 | 1*b* | .. | .. | 1*b* | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 13 | .. | .. | .. | 1*b* | .. | .. | .. | 2*c* | .. | .. | .. | .. | .. |
| | 12 | .. | .. | .. | .. | .. | .. | 2*c* | 4*c* | 5*c* | .. | .. | .. | .. |
| | 11 | .. | .. | .. | .. | .. | .. | .. | 1*c* | 1*c* | .. | .. | .. | .. |
| Metatarsus. | 19 | .. | 1*a* | .. | .. | .. | 1*a* | .. | .. | .. | .. | .. | .. | .. |
| | 18 | .. | .. | .. | .. | 2*a* | .. | 1*a* | .. | .. | .. | .. | .. | .. |
| | 17 | .. | .. | .. | 2*a* | .. | 3*a* | 1*a* | .. | .. | .. | .. | .. | .. |
| | 16 | .. | .. | .. | .. | .. | .. | 1*b* | 1*b* | .. | .. | .. | .. | .. |
| | 15 | .. | .. | .. | .. | .. | .. | .. | 2*b* | .. | .. | .. | .. | .. |
| | 14 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| | 13 | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 2*c* | .. | .. | .. |
| | 12 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2*c* | 3*c* | 4*c* | .. |
| | 11 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1*c* | 1*c* | .. |

*a*. **Dinornis maximus.**
*b*. „ **robustus.**
*c*. „ **torosus.**

BO  S FROM EN

| Length | Mid-width of Shaft in Inches. 2·8 | 2·7 | 2·6 | 2·5 | 2·4 | 2·3 | 2·2 | 2·1 | 2·0 | 1·9 | 1·8 | 1·7 | 1·6 | 1·5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24·5 | ... | ... | ... | ... | ... | ... | 1b | ... | ... | ... | ... | ... | ... | ... | Tibia. |
| 24·0 | ... | ... | ... | 1a | ... | 1a | ... | ... | ... | ... | ... | ... | ... | ... | |
| 23·5 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| 23·0 | ... | ... | ... | ... | ... | 1a | ... | ... | ... | ... | ... | ... | ... | ... | |
| 22·5 | ... | ... | ... | ... | ... | ... | ... | 1b | ... | ... | ... | ... | ... | ... | |
| 22·0 | ... | ... | ... | ... | ... | 1a | 3b | ... | ... | ... | ... | ... | ... | ... | |
| 21·5 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| 21·0 | ... | ... | ... | ... | ... | ... | ... | 1b | ... | 1b | ... | ... | ... | ... | |
| 20·5 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1c | ... | ... | ... | |
| 20·0 | ... | ... | ... | ... | ... | ... | ... | ... | 2b | 1b | ... | ... | ... | ... | |
| 19·5 | ... | ... | ... | ... | ... | ... | ... | ... | 1b | 1b | ... | ... | ... | ... | |
| 19·0 | ... | ... | ... | ... | ... | ... | ... | ... | 1b | 1b | 1c | 3c | ... | ... | |
| 18·5 | ... | ... | ... | ... | ... | ... | ... | ... | 1b | 1b | 2c | ... | 1c | ... | |
| 18·0 | ... | ... | ... | ... | ... | ... | ... | ... | 1b | ... | 2c | 1c | 1c | ... | |
| 17·5 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| 17·0 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3c | |
| 14·5 | ... | ... | ... | ... | ... | 1b | ... | ... | ... | ... | ... | ... | ... | ... | Femur. |
| 14·0 | ... | ... | ... | 1a | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| 13·5 | ... | ... | ... | 1a | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| 13·0 | ... | ... | ... | ... | ... | 2b | ... | ... | ... | ... | ... | ... | ... | ... | |
| 12·5 | ... | ... | ... | ... | 3a | 2b | ... | ... | ... | ... | ... | ... | ... | ... | |
| 12·0 | ... | ... | ... | ... | 2a | 3b | ... | ... | 1c | ... | ... | ... | ... | ... | |
| 11·5 | ... | ... | ... | ... | ... | 1b | 2b | 2b | 3c | ... | ... | ... | ... | ... | |
| 11·0 | ... | ... | ... | ... | ... | ... | 1b | 1b | 7c | 1c | ... | ... | ... | ... | |
| 10·5 | ... | ... | ... | ... | ... | ... | ... | ... | 1c | 1c | 1c | 1c | ... | ... | |
| 10·5 | ... | ... | 1b | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Metatarsus. |
| 10·0 | ... | 1a | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| 9·5 | 1a | 1a | 1a | 1b | 1b | 1b | ... | ... | ... | ... | ... | ... | ... | ... | |
| 9·0 | ... | ... | 2a | ... | 4b | 3b | ... | ... | ... | ... | ... | ... | ... | ... | |
| 8·5 | ... | ... | 1a | ... | 2b | 4b | 3b | 3c | ... | ... | ... | ... | ... | ... | |
| 8·0 | ... | ... | ... | ... | ... | ... | 1b | 5c | 8c | 1c | ... | ... | ... | ... | |
| 7·5 | ... | ... | ... | ... | ... | ... | ... | 1c | 1c | ... | ... | ... | ... | ... | |

a. Pachyornis immania.
b. " elephantopus.
c. Pachyornis inhabilis.
e. Euryapteryx ponderosa.

and MEI

| Length | Mid | | | | | of Shaft | ·6 | ·5 | 1·4 | 1·3 | 1·2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22·0 | | | | | | | | | | | | Tibia. |
| 21·5 | | | | | | | | | | | | |
| 21·0 | | | ... | | | | | | | | | |
| 20·5 | ... | | 4e | 1f | 1h | ... | ... | | | | | |
| 20·0 | 1e | | 2e | 2f | 7h | 6h | ... | | | | | |
| 19·5 | 1e | | [illegible] | 5f | 11h | 7h | 3h | | | | | |
| 19·0 | ... | | | 8f | 11h | 6h | 1h | | | | | |
| 18·5 | ... | | | 1f | 1h | 4h | 2h | | | | | |
| 18·0 | ... | | | ... | 5g | 3h | 1h | | | | | |
| 17·5 | ... | | | 1g | 1g | 2g | ... | | | | | |
| 17·0 | ... | | | ... | ... | 3g | ... | | | | | |
| 16·5 | ... | | | ... | ... | ... | 4i | 11i | | ... | | |
| 16·0 | ... | | | ... | ... | | 1i | 24i | | ... | | |
| 15·5 | ... | | | ... | ... | | 2i | 12i | | 4i | | |
| 15·0 | ... | | | ... | ... | | 1i | [illegible] | | 6i | | |
| 14·5 | ... | | | ... | ... | | ... | | | 2i | | |
| 14·0 | ... | | | | | | | | | 1i | | |
| 12·5 | ... | | 2e | | | | | | ... | | | Femur. |
| 12·0 | ... | 1e | 2e | 1f | | 2h | 1h | ... | ... | | | |
| 11·5 | 4e | 3e | 7e | 8f | | 22h | 5h | 1h | ... | ... | | |
| 11·0 | ... | 1e | 6e | 7f | 7f | 18h | 6h | 1h | ... | ... | | |
| 10·5 | ... | ... | 2e | 3f | 4f | 8h | 6h | ... | ... | ... | | |
| 10·0 | ... | ... | ... | ... | 5g | 2h | 6h | 7i | 11i | ... | | |
| 9·5 | ... | ... | ... | ... | ... | 5g | 7i | 28i | 35i | 6i | | |
| 9·0 | ... | ... | ... | ... | ... | ... | ... | 4i | 17i | 6i | | |
| ·5 | 2e | ... | 1f | 2f | ... | ... | ... | ... | ... | ... | | Metatarsus. |
| 9·0 | 6e | 3e | 5f | 13f | 14h | 5h | 2h | ... | ... | ... | | |
| 8·5 | ... | 2e | 10f | 19f | 22h | 12h | 2h | ... | ... | ... | | |
| 8·0 | 1e | 2e | 1f | 7f | 14h | 1h | 2h | 4i | ... | ... | | |
| 7·5 | | ... | ... | | 12g | 5i | 8i | 40i | 19i | 1i | | |
| 7·0 | | ... | ... | | 2g | 4g | 5i | 14i | 18i | 1i | | |
| 6·5 | | | | | | | | | 3i | 1i | | |

Inches.

f E
g.
h. M
i.

## Art. LXVII.—*On the Discovery of Moa-remains on Riverton Beach.*

By C. A. Ewen.

Communicated by Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 7th August, 1895.*]

On the 13th March, 1895, Messrs. Graves, Brodrick, and Ewen discovered the skeleton of a moa [skeleton I.] on the sandhills about eight miles from Invercargill, near the Invercargill-Riverton beach road, and about one mile from the sea. These sandhills are constantly shifting with every gale that blows. Islands of sand are dotted about, held together by flax-bushes, and marking the original level of the hills. The bones had been buried beneath 8ft. or 10ft. of sand, and were consequently in a very fair state of preservation. Only a portion of the pelvis was visible; the rest of the skeleton was buried in the wet sand which had not dried sufficiently to be affected by the wind. The sand was scraped away, and, after an hour's work, the whole skeleton was exposed to view. The bird appeared to be lying as it had died, its legs doubled under its body, and its neck stretched out on the sand. The pelvis and ribs were brittle, but the leg-bones and vertebræ were in very fair condition. All the bones were gathered together and removed to Invercargill. Unfortunately, the jolting of the buggy over the hills damaged the tender bones and broke the sternum to pieces. However, the skull and larger bones arrived in safety. In a day or two they were dry enough to be packed, and were placed together in a box to be brought to Christchurch. The gizzard-stones were found with the skeleton.

A few days later, on the 18th March, two members of the same party discovered another almost-complete skeleton [skeleton II.] about half a mile from the spot where the first was found. As in the first instance, only the back of the pelvis was visible, the rest of the bird being buried in wet sand as before. The skull was a particularly good specimen, and the ribs and smaller bones were carried to Invercargill with less damage than on the former occasion.

About two hundred tracheal rings were found with this skeleton. The ground around was searched for other skeletons, but no other bones could be found. About 300 yards away a considerable quantity of egg-shell was, however, gathered together, enough to fill a pint measure. It is quite possible that, as the sand shifts in the course of time, other skeletons will be exposed to view.

Upon digging down about 2ft. we found some rotten flax-sticks, and a bed of water-worn shingle. Probably the birds had been drowned and washed down this old watercourse, became stranded, and were gradually buried beneath the accumulating sand.

It has been stated that in the early part of this century the moa was hunted by the Maoris in Southland. I am of opinion that this statement is not correct, as Captain William Stevens, who was one of the earliest settlers in Riverton, states that he believes the moa has been extinct in Southland for many years, equal to several generations of the Maori race.

They must at one time have been numerous, as the larger bones have been found in many parts of the district. In this connection Captain Stevens has written me an interesting letter, which I give in full. Writing on the 25th May, 1895, he says, "I arrived here in the first week of 1843, and at that time there was a deal of talk among the natives about the moa, but I could never find that any of them had ever seen one—at least, a live one. What I heard about the moa was just handed down by tradition from father to son. I can give you some names of the oldest Maoris I knew, but their ages I could only guess. The following are the names of a few I was well acquainted with: First, Temarama, aged seventy, father of Topi, present chief of Ruapuke; second, Pekau, about eighty; third, Temoau, about eighty; fourth, Mokau, about eighty; fifth, Pararaoa, about seventy; sixth, Haunmai, about eighty-eight. I could mention many more—perhaps fifty more—but they were very old, and too imbecile to be relied on."

## Note by Captain F. W. Hutton.

Both of the skeletons referred to above belong to adult individuals of *Dinornis maximus*, as the following measurements of the leg-bones and skulls will show (measurements in millimetres):—

| | Skeleton I. | | | | Skeleton II. | | | |
|---|---|---|---|---|---|---|---|---|
| | Length. | Proximal Width. | Middle Width. | Distal Width. | Length. | Proximal Width. | Middle Width. | Distal Width. |
| Tarso-metatarsus .. | 415 | 117 | 61 | 165 | 495 | 124 | 56 | 168 |
| Tibio-tarsus .. | 876 | 201 | 69 | 104 | 889 | 201 | 66 | 109 |
| Femur .. .. | 391 | 187 | 66 | 160 | 406 | 145 | 66 | 179 |

Dimensions of the Skulls.

| | | Width at Squamosal Processes. | Width at Temporal Fossæ. | Width at -orbital cesses. | Distanc betwee Temporal Ridges. | Length of Cranial Roof. | Height of Cranium. | Length of Mandible. |
|---|---|---|---|---|---|---|---|---|
| Skeleton I. | 104 | (?) | 76 | 136 | 48 | 97 | 52 | 222 |
| Skeleton II. | 94 | 107 | 69 | 134 | 43 | 98 | 53 | 216 |

It appears, therefore, that the smaller bird has a broader cranium and slightly longer beak than the larger bird. There are also the following differences between the two skulls: in skeleton I. the basi-occipital is not so deep, and the mamillary tuberosities are much more developed, than in skeleton II.; the par-occipital processes extend further backward, and the supra-occipital ridge projects further over the condyle. The temporal fossæ are rather shallower and narrower than in No. II.; and the squamosal processes are directed more forward. Also, in No. I. the cranium is shorter in the basi-sphenoidal region than in No. II., a line connecting the points of the post-orbital processes passing close in front of the basi-pterygoid processes. The pre-maxillæ are longer and considerably broader, and the mandible is longer and more curved downward, in No. I. than in No. II. There are no feather-pits on either skull.

With reference to other parts of the skeleton: In No. I. the toe-bones are smaller and the scapulo-coracoids are stouter than in No. II.; and there are considerable differences in the hæmal ridges of the thoracic vertebræ. The pelves and sterna are too imperfect for comparison.

With No. I. skeleton only seven tracheal rings were found; they were of the hoop-like pattern, but were imperfectly ossified, being open in front, and were too fragile to be preserved. Among the fragments of the sternum I found nine small pieces of egg-shell, which had been picked up by the collectors with the bones. There can, I think, be no doubt but that this egg-shell was inside the bird when it died, and that, consequently, it was a female; for, as the body was found on the sea-shore, it could not have been sitting on a nest. This skeleton has been presented to the Museum by Mr. Ewen.

In No. II. skeleton the atlas vertebra is abnormal, as it has no bony bridges for the vertebral arteries; and the seventh thoracic vertebra (No. 28) appears to have been anchylosed to the pelvic vertebræ, as it is missing. A number of tracheal rings were found with the skeleton, and all are

of the oval, slender, hoop-like type; there were no thick, tube-like rings.

So far I have merely stated the facts; but it is impossible to avoid making a few speculations as to the meaning of the differences between the two skeletons. These must be due either to (1) specific differences, or to (2) sexual differences, or to (3) individual variation. If the last is the case, we ought to find all sorts of intermediate variations, as well probably as some more extreme than those exhibited by the two skeletons. If, however, the differences are due either to the first or to the second cause they ought to be tolerably constant. If due to sexual differences, the numbers of each type ought to be nearly equal; but, if they are due to specific differences, then one kind might be much more common than another.

The skulls of *Dinornis* in this Museum are not sufficiently numerous to enable me to form a definite opinion on the subject, but I am inclined to think that there are two types, which are equally numerous, but very different in size.

In confirmation of this view, I would point out that all the peculiar features of the skull of No. I. skeleton (with the exception of the great breadth of the premaxillæ) are also seen in Sir R. Owen's drawing of the skull of the small specimen of *D. robustus* which was found at Tiger Hill, in Otago, and is preserved in the York Museum. Now, this Tiger Hill specimen was accompanied by four half-grown chicks, so that probably it was a female also.

Perhaps the imperfect ossification of the tracheal rings in skeleton I. is another sexual character.

## Art. LXVIII.—*On the Behaviour of Two Artesian Wells at the Canterbury Museum.*

By Captain F. W. Hutton, F.R.S., Curator.

[*Read before the Philosophical Institute of Canterbury, 3rd July, 1895.*]

Previous to March, 1894, the Museum was supplied with water from a well sunk into the first water-bearing stratum, and probably between 90ft. and 100ft. in depth. This failing to give a sufficient supply, a second well was sunk, which reached the second water-bearing stratum, at a depth of 190ft. from the surface, on the 23rd March, 1894. A glass gauge, connected with this well, was put up inside the Museum on the 9th April, and the height at which the water stood above

the stone sill of the back door of the Museum was registered: this was 9ft. 8¼in. On the 11th it went down to 9ft. 6in., and on the 21st it had risen to 9ft. 8¾in. This I call the "deep well."

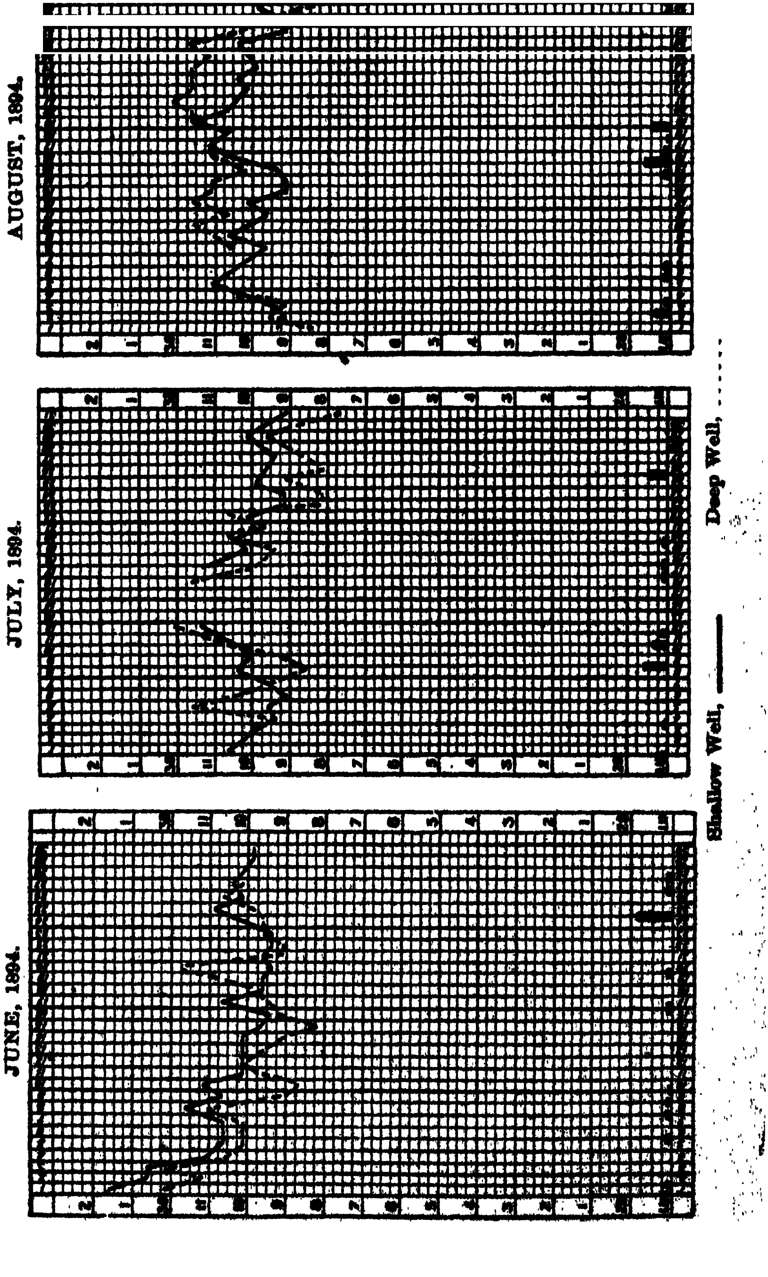
The top of the iron pipe of the old well—or shallow well —I found to be 2ft. 10in. above the stone door-sill, and the water stood 2in. or 3in. below the top; so that there was a difference of about 7ft. in the height of the water in the two wells.

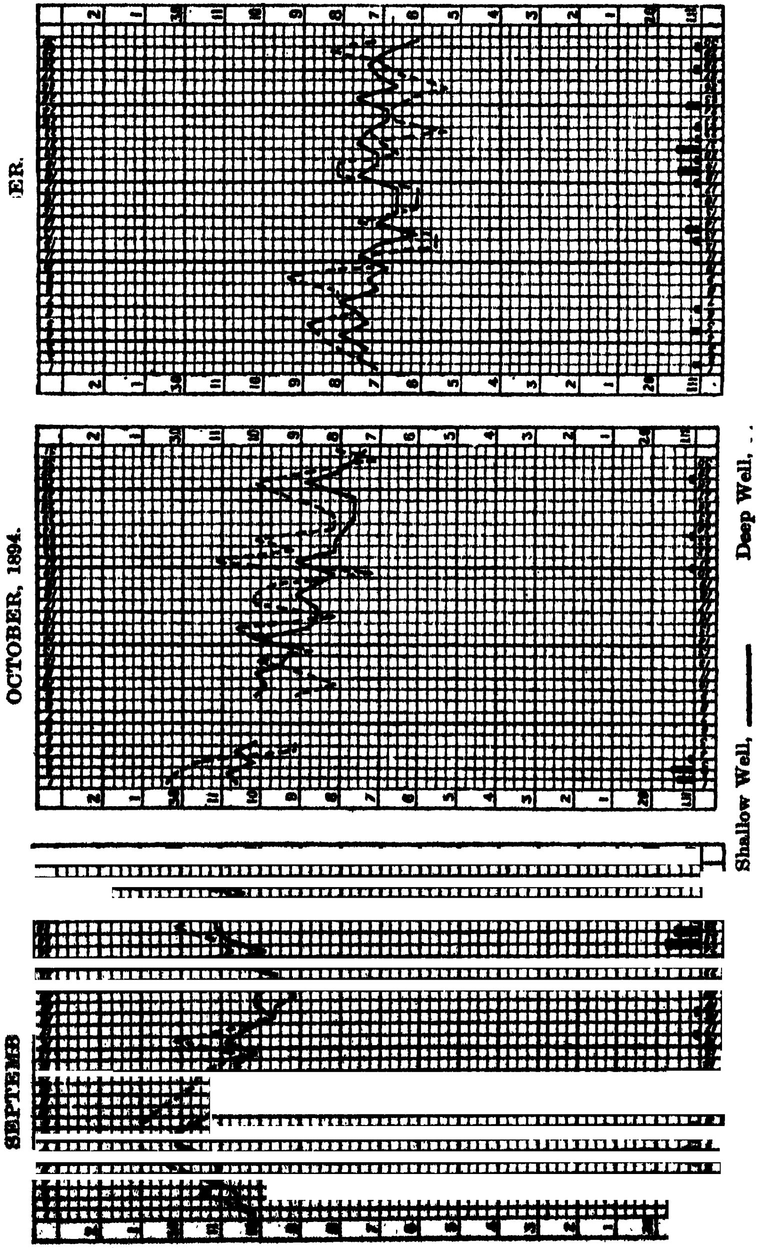
At this time the rainfall was not registered in Christchurch, but arrangements were being made to put up a gauge in the Public Gardens; and Mr. A. L. Taylor, the head gardener, has kindly supplied me with the rainfall from the 1st June, 1894, to the 31st May, 1895.

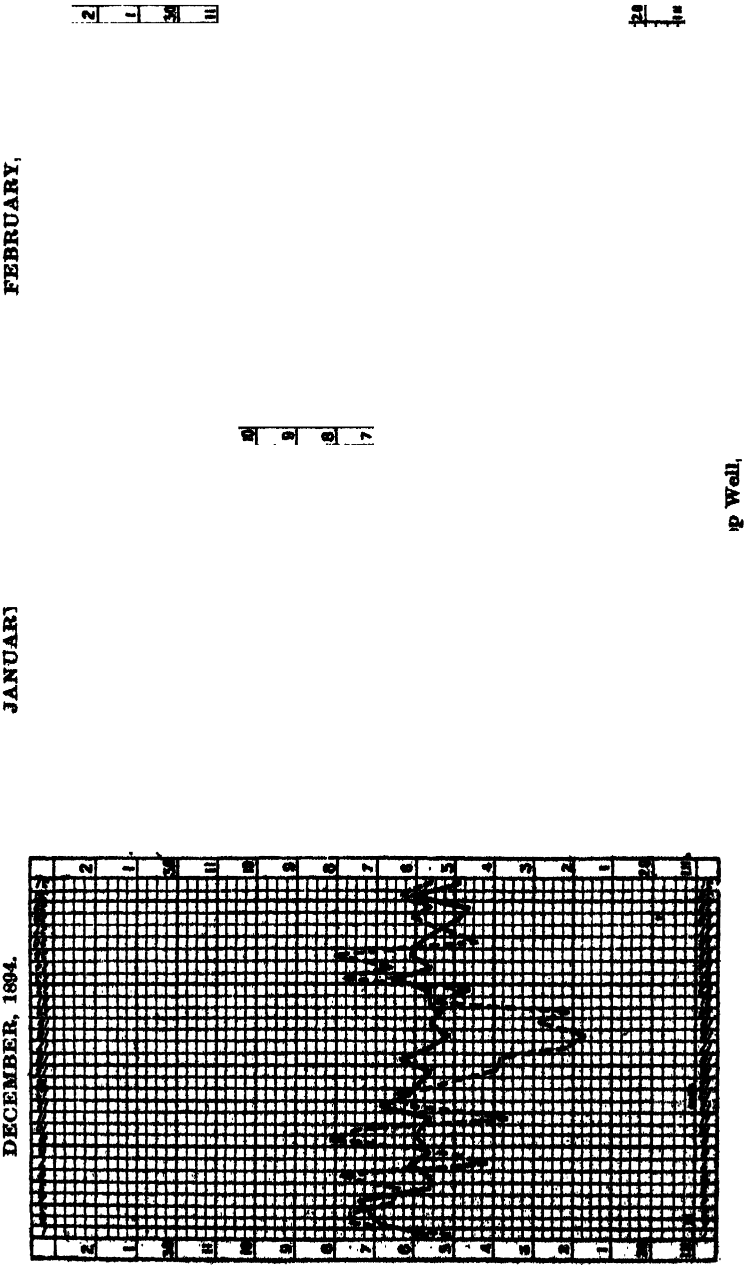
Meantime, as it was known that the artesian wells near New Brighton were affected by the height of the tide, I made hourly observations on three different days to see whether the Museum wells were also affected; for, if this were the case, a tidal correction would have to be applied to every observation. I found, however, that the tide had no appreciable effect on either of the wells.

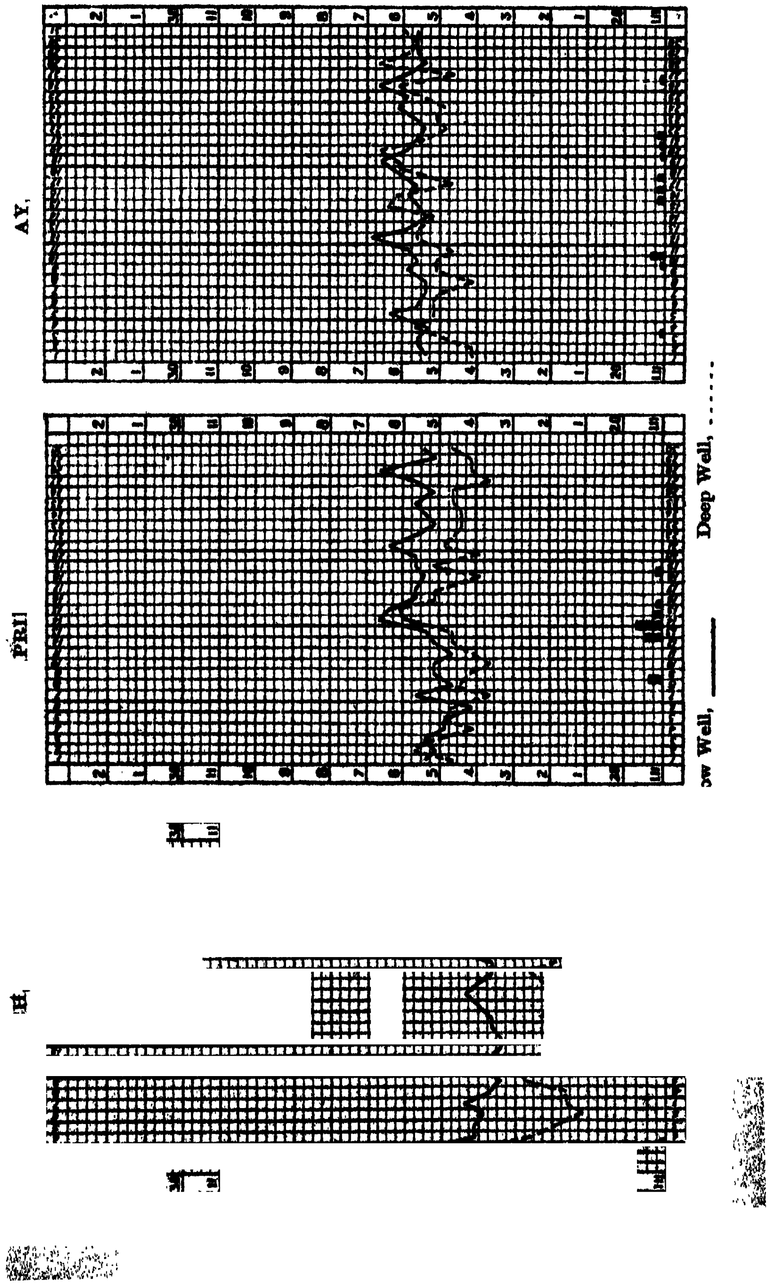
At first I had some little difficulty in reading the deep well on account of the hydraulic ram, which would occasionally jamb; but I remedied this by stopping it altogether and keeping it stopped during the whole period of the observations. These observations were made between 10 a.m. and 11 a.m. each day. As the glass gauge reached only to 10ft. above the door-sill, all observations above that level could only be conjectural, and I gave up making them. When the water rose above the top of the iron pipe in the shallow well I made a cardboard collar to lengthen it. On account of leakage these readings are only approximate, but they are fairly accurate.

The results of the observations I give in a series of twelve diagrams, one for each month, on which the daily rainfall in the Public Gardens is also shown. In these diagrams the figures in the right and left columns are the number of feet and inches from the datum-line on the door-stone, and to read the height of the deep well 7ft. must be added. Thus, on the 1st June, 1894, the height of the shallow well was 3ft. 1¼in., and that of the deep well 10ft., above the door-sill. The daily fluctuations of the shallow well are represented by a continuous line; those of the deep well by a broken line. The rainfall is shown in the usual way at the bottom of each diagram. The figures at the top and bottom of the diagram are the days of the month, and the thick longitudinal lines divide the month into weeks.


AUGUST, 1894.
JULY, 1894.
JUNE, 1894.
Shallow Well, ——
Deep Well, ......


ER.
OCTOBER, 1894.
SEPTEMB
Shallow Well, ——— Deep Well, . .


DECEMBER, 1894.
JANUARY
FEBRUARY,
Well


AY,
PRIL
Deep Well, .......
ow Well, ———

I will first take the connection between the rainfall and the height of the water in the wells:—

June, 1894.—May, 1894, closed with heavy rain, and on 1st June both wells stood very high; but, although slight rain continued at intervals until the 10th, both wells had fallen considerably by the 15th. Heavy rain on the 24th made them rise again.

July, 1894.—During the first week in July the wells again went down; but the rain on the 8th and 10th, although not heavy, made them overflow and sent them up again to a height perhaps not much less than they had during the first week in May. By the 24th they were down again. It is remarkable that the rain which fell on the 8th and 10th May, although only 0·17in. more than that which fell on the 24th June, should have sent the wells up so much more. Two explanations suggest themselves: one is that the rain of the 24th June fell more rapidly and, in consequence, ran mostly off the surface; the other is that the rain of the 24th June was local, while that of the 8th and 10th July was more widely spread. I have not sufficient data to determine which of these two explanations is the more probable. The rain of the 25th July again raised the wells slightly, but by the end of the month they had both fallen to lower levels than any they had stood at during the two months.

August, 1894.—The rains of the 2nd and 3rd August again raised the wells,* but by the 8th they had again fallen. Continuous light rain from the 14th to the 19th raised them once more, but not so high as might have been expected. After this they sank, and before the end of the month had attained the average level.

September, 1894.—Continuous light rain fell during the whole of the first week. Both wells again overflowed, and did not come down to the average level until the 18th. Heavy rain on the 24th and 25th again sent them up, and they continued high until the end of the month.

October, 1894.—Rain on the 1st and 2nd kept the wells up; but they gradually fell during the rest of the month—there being no rain—until at the close they stood lower than they had done before, and the average level of June to October was never again maintained during the rest of the year.

November, 1894.—In this month the rain was fairly well distributed, and the wells kept at an average which was 3in. below that of June to September, the drop from one to the other taking place during the dry weather in the middle of October.

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* The defect in the record of the deep well at this time is owing to the ram having gone wrong.

December, 1894.—In this month the rainfall was very small, and the wells fell another inch. Towards the end of the month another fall of about ½in. occurred.

January, 1895.—This month opened with rain, which, however, did not affect the shallow well, although the deep well rose. The next week, from the 6th to the 11th, was rainy, and both wells went up, falling again on the 16th. Showery weather once more raised them a little; but after the 20th they both fell, and—especially the deep well—went down to levels not before reached.

February, 1895.—Slight showers between the 3rd and 7th did not affect the wells, which continued to go down until the 20th or 22nd, when the rain raised them a little; but they had fallen again by the 27th.

March, 1895.—There was practically no rain during the first fortnight of this month, and the wells fell slightly until the 20th, when four days of rain sent them up again to the level they had at the end of January.

April, 1895.—During the first week of this month the wells fell slightly; but rain occurred on the 8th and again from the 12th to the 16th; the wells rose to the level of the middle of January, and continued at this level notwithstanding that there was no more rain.

May, 1895.—There was but little rain during this month; nevertheless the wells did not fall, but kept steadily the average of the latter part of April.

The following table gives the average height of the wells and the rainfall for each month:—

| —— | Shallow Well. | Deep Well. | R |
|---|---|---|---|
| 1894. | Ft. in. | Ft. in. | In. |
| May .. .. | 2 7½ | 9 8 | (?) |
| June .. .. | 2 10 | 9 10 | 1·84 |
| July .. .. | 2 10 | 9 10 | 2·09 |
| August .. .. | 2 10 | 9 10½ | 2·51 |
| September .. | 2 10½ | 9 10½ | 3 46 |
| October .. .. | 2 9 | 9 9 | 0·50 |
| November .. | 2 7½ | 9 7 | 2·57 |
| December .. | 2 6 | 9 5 | 0·30 |
| 1895. | | | |
| January .. .. | 2 5½ | 9 5½ | 2·28 |
| February .. .. | 2 4½ | 9 2 | 1·21 |
| March .. .. | 2 4½ | 9 2 | 2·44 |
| April .. .. | 2 5½ | 9 4½ | 1·71 |
| May .. .. | 2 5¾ | 9 5¼ | 1·85 |

It thus appears that both wells are very sensitive to rain, rising rapidly and falling again; but not so rapidly as they

rise. Exceptions are the rain of the 1st and 2nd January, which did not affect the shallow well although the deep well rose, and the rains of the third week in November, which had no effect on either of the wells. In both these cases several weeks of drought had preceded the rain, and it seems probable that the dry ground soaked up the water and allowed none to penetrate to the reservoirs connected with the wells.

But, although the wells rise with rain, they also rise without any rain being recorded. This may, perhaps, be sometimes due to rain falling outside Christchurch—especially in cases like those of 25th July, 27th November, 12th December, 16th and 27th March, and 9th May, when the shallow well rose rather before rain fell in Christchurch. On the 26th December heavy rain fell at Springfield and the Malvern Hills, although none fell at Christchurch. Both wells fell that day, but next day the deep well rose slightly, although the shallow well still fell.

Far more important is the periodical rise shown on Sundays and holidays, which cannot possibly be due to rain, and which is specially noticeable in the rise of the shallow well every Sunday. This well really rises every night, and on Sunday morning does not fall as it does on week-days. The rise varies from $\frac{1}{4}$in. to $1\frac{1}{8}$in., and the average is rather more than $\frac{3}{4}$in. The same occurs with the deep well, but it is masked by the great and rapid fluctuations which take place in this well. These, as recorded on Sundays, vary between $-1$in. and $+4$in ; but here also the average comes out about $\frac{3}{4}$in. rise. On the Prince of Wales' Birthday (9th November), Christmas Day (Tuesday), and Good Friday (12th April), both the wells rose. On the Queen's Birthday (24th May) the shallow well rose and the deep well fell. On the anniversary of the province (Monday, 17th December) both wells fell, just as they generally do on a Monday. Easter Monday was rainy, and the wells rose with the rain. This periodic rise must depend on a constant supply of water, either from some lower-lying water-stratum or from the bed of the River Waimakariri.

I have been unable to get complete information about the floods which took place in the River Waimakariri during the year, but I kept a record of the north-west winds, and these are generally followed by floods; and, as these are the only floods unaccompanied by rain, they are the only ones which can be used to ascertain if the level of the wells is affected by the height of the river.

Hot north-west winds occurred on the following days: 19th October, 9th and 10th November, 18th November, 24th November, 1st December, 17th December, 7th, 8th, and 9th

March, 15th March, and 22nd April. Of these the hot winds of the 1st and 2nd December, and of the 7th, 8th, and 9th March, caused heavy floods in the river sufficient to be noticed in the newspapers. The hot winds of the 13th and 24th November and of the 22nd April were accompanied by rain, and must therefore be omitted. With the other seven it did not rain, but that on the 9th November is complicated by the holiday. With reference to the others, the diagrams show that the wells fell on the 19th and 20th October and on the 10th and 13th November. On the 24th they were stationary. On the 1st December they fell. During the heavy floods of the 2nd and 3rd the rise on the 2nd was no doubt due to that day being Sunday, for on the 3rd the deep well remained steady, and the shallow well rose slightly. On the 5th and 17th December both wells fell; on the 7th March they rose; on the 8th the deep well remained steady while the shallow well fell; and on the 9th the deep well rose and the shallow well fell. On these two last days the river was in high flood. On the 15th March the deep well rose and the shallow well remained steady. It follows therefore that the wells do not rise with the river, but are apparently unaffected by it.

Up to the middle of January, 1895, the two wells fluctuated fairly well together, the average difference in height being 7ft. But on the 22nd January the deep well fell far more than the shallow well, and this relatively lower level was maintained until April, when the two wells nearly resumed their old relations, the deep well being about 6ft. 11in. higher than the shallow well. Possibly this may have been due to the water from the deep stratum being used for watering the streets during the hot months.

Some of the vagaries of the deep well between the 12th and 29th November may be due to large quantities being used for washing moa-bones. During the latter part of October and again in December the height of the water in the deep well was very variable. Great falls occurred between the 14th and 20th December, and between the 23rd January and the 2nd February, and a third between the 16th and 21st February. For these I cannot account.

The conclusions which seem to be justified from the observations of so short a period as one year are as follows:—

1. The deep well fluctuates more than the shallow well. This is, no doubt, partly due to the far greater number of wells sunk into the first stratum, all of which would rise and fall together; consequently it would require more water to raise them all an inch than if there were fewer of them. But it may be partly due to the head of water above the level of Christchurch being smaller in the deep stratum than in the shallow stratum.

2. Many fluctuations, apparently erratic, are no doubt due to irregular causes of which I can give no account—such as the stopping of rams; less pumping by windmills on calm days; rainfall outside Christchurch; watering the streets; opening of new wells, &c.

3. Certain fluctuations are sufficiently regular to show cause and effect: they are—(*a*) Rise after rain, unless the ground is very dry; (*b*) rise at night, owing to less water being used.

4. The rise at night in each well is about equal; consequently, as the second stratum fluctuates more rapidly than the first stratum, the supply to the first stratum must be larger than that to the second.

5. This rise without rain appears to be the main source of supply. It must be due either to water running in from the bed of the River Waimakariri, or to some still lower water-bearing stratum leaking into the upper ones.

6. The height of the water in the wells is not affected by the height of the river. It is therefore improbable that the supply is from a leak in the river-bed.

7. The regular inflow—independent of rain—is, with each stratum, greater than the present outflow by night, but smaller than the outflow by day.

Lastly, we come to the question of the annual rate of lowering of the water. Of course, one year's observations are not enough to settle this point accurately, but they are better than nothing. The shallow well stands about 1¾in. and the deep well about 2¾in. below the level of last year. The annual rainfall was 22·21in., which is 2in. or 3in. below the average; but I do not think that this will account altogether for the fall. No doubt heavy rain would make the wells go up again to last year's level, but they would go down again in two or three weeks.

The shallow wells are estimated by Mr. T. Danks to have fallen between 6ft. and 7ft. during the last thirty years, which gives an average annual fall of between 2⅜in. and 2¾in. Mr. H. Oakley has estimated that they have fallen 3ft. in twenty years, which is rather more than 1¾in. a year. Mr. Oakley also thinks that the deep wells have fallen 3ft. in six or seven years, which is an average of 5¼in. a year. This rate of lowering requires further investigation; but no doubt it is serious, and increasing year by year.

ART. LXIX.—*On the Affinities of* Harpagornis: *a Letter to Professor T. Jeffery Parker by R. W. Shufeldt, M.D., Smithsonian Institution, Washington, dated 25th January, 1895.*

[*Read before the Otago Institute, 8th October, 1895.*]

IT has given me great pleasure to do for your friend Mr. Hamilton what you requested of me in your valued letter of the 14th ultimo, just received. His excellent photographs of the bones of *Harpagornis*, which came safe in your letter, were studied by me with interest. I mounted all six of them on cards, and yesterday compared most carefully all the characters they presented with a number of American raptorial birds and others. I also compared what Haast had to say on *Harpagornis* in the "Transactions of the New Zealand Institute," vol. vi., 1873.

Without any doubt whatever, *Harpagornis* has among existing birds its closest allies among the true eagles, and the relationship is by no means very remote. I compared it with a skeleton of *Aquila chrysaëtos*, also with *Thassaëtus pelagicus* and *Haliæetus leucocephalus* and others. In various parts of its skeleton *Harpagornis* exhibits characters found in any one of these several genera, and about in the same proportion: that is, in a number of characters it agrees with *Aquila*, with *Thassaëtus* in an equal number, and so on for *Haliæetus* and others. It had a narrower skull in proportion to its length than has any modern existing eagle known to me. The pre-acetabular region of the pelvis of *Harpagornis* was also very short, but this is a common character in many extinct birds. Having fenestræ in the sternum means but little among eagles, as they may or may not be present in individuals of the same genus. Moreover, I have seen sterna of eagles wherein the fenestra occurred upon one side of the carina and not upon the other.

It is perfectly safe to say that *Harpagornis* represents a more or less generalised aquiline type, and might easily have been the common ancestor to a number of genera of existing modern eagles, as, for example, *Haliæetus*, *Aquila*, and *Thassaëtus*. In any natural scheme of classification it might, with the greatest propriety, be placed between the genera *Aquila* and *Thassaëtus*, and it would be standing as near where it belongs as we can possibly show at the present time.

## Art. LXX.—*Denudation as a Factor of Geological Time.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 10th June, 1895.*]

The many discussions among geologists and physicists which have taken place from time to time as to the age of the earth have brought under review wide diversities of opinion. The mind is lost in wonder as we go back and back from age to epoch, from epoch to period, and from period to era in the order of geological time as illustrated by stratigraphy, or the sequence of the rocks; but these chronological terms only represent one aspect of activity in the full history of the earth. Time was when the conditions of the earth were such that life, as we know it to-day, could not exist; when the waters which now cover its surface could not have remained as a liquid; and when from pole to pole the rocks were heated beyond the possibility of sustaining life. The geologist is unable to say how long the earth remained in the condition of inability to sustain organic life, for, reasoning from the known, his aim is to estimate time by the changes such as he knows must have taken place since life first became possible on the earth, and when differentiations were the fewest consonant with what is understood as the maintenance of the simplest organisms. The physicist, on the other hand, deals with the history of the earth from an altogether different standpoint. He views it as something to be interpreted only by the application of certain laws to physical or assumed physical conditions, his conclusions being based—first, upon the assumed original temperature of the earth, and its annual rate of cooling; second, upon the loss of energy of the earth's rotation in virtue of the moon's attraction, as evidenced by the tides; and third, upon the origin and age of the sun as a dispenser of heat. On the supposed original temperature of the earth and its annual loss of heat by radiation, estimates have been made that the globe could not have become consolidated less than twenty millions of years ago, nor more than four hundred millions ago; for, had the latter been the case, there would have been no alteration of temperature when descending into the earth, such as is everywhere experienced by miners when sinking or boring through the earth's crust. As to the loss of energy of the earth's rotation owing to the friction of the tide-wave, Sir William Thompson contends that, had the earth become solid some ten thousand million years ago, or, indeed, any period beyond one hundred million years, the polar flattening would have been greater than now,

owing to the more rapid motion which would have taken place; whilst Professor Tait, agreeing generally with the views put forward by Helmholtz and Newman, says that "the amount of heat produced by the impact of masses from space which are assumed to have given origin to our sun could not have supplied the earth even with its present quantity of heat for a much longer period than twenty millions of years. *Nature*, 3rd January, 1895, contains a criticism by Mr. John Perry of Sir William Thompson's (now Lord Kelvin) estimate, in which it is stated that "if at the beginning of time there was an increase of 1° Centigrade in 45ft. (towards the earth's interior), and now there is an increase of 1° Centigrade in 90ft., the lapse of time is 28,930,000,000 years, or 290 times Lord Kelvin's estimate, and the core has cooled from 8,000 to 4,000 degrees."

It will thus be seen how diverse are the views of the physicists who deal with the age of the earth from a mathematical standpoint, and it seems very doubtful whether such estimates as those given above have any scientific value whatever. Were it to be announced that a bank-note for a large amount had been lost either between Napier and Dunedin, or between those places and the Cape of Good Hope, the announcement would be just as general and unsatisfactory as that made by Sir William Thompson and others as to the age of the earth. It is true that such estimates often form the basis of what are termed "working theories"; but as standards of scientific value they are of small importance, and it is well to keep this in mind when considering the question of earth-changes such as we now see in daily progress. But it is curious how geologists, having received a "time-period theory" from the mathematicians, have endeavoured to bring that theory into the full light of day by striving to show that the organic and surface changes on the earth must have required an allowance of time equal to what the mathematicians say must have gone by since the earth became a solid mass and assumed its present form. The late Dr. Croll, for example, suggested a period of not less than sixty millions of years as being needed to bring about the changes or the conditions such as we now have; whilst Dr. Houghton, in the second of his able lectures on "Physical Geography," pp. 94–95, estimates "the whole duration of geological time down to the Miocene-Tertiary epoch at 152,675,000 years, and for the whole duration of geological time a minimum of two hundred millions of years." Now, Croll and Houghton have based their estimates upon the maximum thickness of the known stratified rocks, and with this they have taken the rates of denudation of certain rivers as determined by the amount of sediment which such rivers annually carry to the sea. Thus, Dr. Houghton says that the total

thickness of all the "Azoic, Palæozoic, and Neozoic rocks amounts to 177,200ft., and, allowing 861·6 years as the time required for the denudation of 1ft. of surface in the several river-basins, at least a hundred and fifty-two million years must have passed of geological time down to the close of the Miocene-Tertiary epoch."

I have purposely prefaced my subject on "Denudation as a Factor of Geological Time" with the views which are held, or have been held, by the leaders of geological thought, as it enables us to see what vast steps have been taken backward, as it were, into the past since the days when men thought that the earth's history dated back some four or five thousand years before the Christian era. But, great as is the factor of denudation in estimating the history of change on the earth's surface, the traces of past life as unfolded in the stratified rocks raise questions for consideration which, as far as our present knowledge goes, can only be settled by assuming long intervals of time, as by no other means—unless special centres of creation are recognised—can it be supposed that animals and plants representing a past highly-differentiated fauna and flora could have dwelt on the earth and have become adapted to conditions such as do not now and could not now exist. And here I would emphasize a fact too often overlooked by naturalists and geologists—viz., that, whilst change has gone on ever since time was, at no two moments are the conditions of existence the same. This is why life is ever-changing and various. We cannot have two plants or two animals alike, for, try how we may, we cannot place them as to origin and treatment under absolutely the same conditions. This is nature's mode of dealing with matter. To change is to live, and could we learn the art of changing our physical nature—that is, of constantly adapting ourselves to environment—the "elixir of life" would be ours, and man's mastery over nature would be complete. But, fortunately for us, nature will still be our master, for no modification, no change, will ever differentiate the flesh into spirit or the spirit into flesh; for, as Marcus Aurelius puts it,—

> What springs from earth dissolves to earth again,
> And heaven-born things fly to their native seat.

When this earth of ours first became solidified, as it must have become in the process of cooling, many years passed by before its temperature was sufficiently cool to enable the watery vapour of the atmosphere to be condensed. Water does not and cannot remain as water, except under special conditions, above a temperature of 100° C. or 212° Fahr. It is possible that the vapour enveloped the whole earth to the point of saturation at a temperature much above what is now experienced. My reason for thinking so is that the dimen-

sions of the earth were much greater than now, and the pressure of the atmosphere on the surface was therefore less. We know as a physical fact that there is a relationship between the pressure of the air and the change of water into vapour, and if the pressure of the air, as suggested, was less in the earlier history of the earth and long after the surface-temperature was below 100° C. the conditions then existing were quite unlike what we are acquainted with in these times. Then the water would have been heated by convection from below rather than by conduction, as now, from above. There would certainly have been more evaporation, and the slightest temperature-changes in the atmosphere such as there would necessarily be must have brought about heavy mists and a moist heated climate over the entire surface of the earth. Conditions such as these would produce abundance of life without great differentiations, for differentiations in the organic world are the direct outcome of temperature contrasts. When the earth was in process of solidifying it was with its atmosphere in direct contact with its external surroundings. The temperature of outer space—that is, of the space outside the limits of the atmosphere—is said to be 250° or more below the zero of Centigrade. An incandescent earth with a temperature outside its enclosing envelope approaching the zero of cold is placing two opposites in direct contrast to one another. At such a time there were no contrasts within the earth itself, and it was only when the earth began to part with its heat into outer space at an unequal rate, as it does now, that earth-contrasts became possible, and that differentiation in the animal and vegetable world began. But these differentiations for a long time were necessarily small, seeing that they varied in proportion to the conductivities and radiating capacities of the surface-rocks at that time. As pointed out above, the waters were heated by convection rather than by conduction, and it was by this means that the climatic conditions of the earth were similar, or nearly so, throughout each zone.

It will appear from these considerations that when life first made its appearance on the earth the types were the simplest possible; for high types, both in the animal and vegetable kingdom, imply great differentiations and wide contrasts. Thus the types have continued to increase in number and complexity in direct proportion to the changes which have been brought about on the earth's surface by the operation of those laws which depend upon the inequality of temperatures for their effective action. From this it follows that life is dependent on environment. To suppose that animals or plants could flourish under conditions not adapted or suited to them is to assume an impossibility. Plants and animals in a state of nature are best adapted to their environment, because were

it otherwise they would die. It is therefore a manifest impossibility for the climates and environment of the past to have been similar to what they now are. We know what the organic results are of our present environment, such as have been brought about by differentiations and adaptations operating through all past time; but, because these are known, can it be asserted or even suggested that similar causes operated to bring about the organic results such as are found among the ruins and rearrangements of the past? Were the physical conditions of New Zealand to-day similar to what they were when the Dinornis and Harpagornis were found living, we might wonder what has caused their disappearance at a comparatively recent period; but the operation of the law which brought about the extinction of Palæotherium in the Lower Tertiary, of Deinotherium in the Pliocene, and of the Mastodon in the American drift, no doubt brought about the disappearance of the noble avifauna of New Zealand. The physical conditions in the earth are widely unlike what they once were, and every remove, every change, is necessarily accompanied by modifications and adaptations in the organic world. Nor could anything else be expected if we suppose that organic life always exists under conditions best adapted to it. Every remove onward in time is like the effect produced upon a people by great social or political changes. To many, a social or political change means succour, to others disaster; but the impulse is nevertheless forward, as evolution always is. Viewed from this standpoint, it is evident that life in each age, epoch, period, and era was the best of its kind suited thereto; but can it be imagined that an estimate of earth-change such as is now in operation can be taken as a basis in estimating changes in the ages gone by—a complex differentiation by which to interpret a simple one in the order of nature? All palæontological evidence implies simpler physical conditions in times gone by, and a growing complexity as we approach Post-Tertiary times; and it is therefore impossible, without running serious risk of error, to base the physical changes of the past upon what we now see in progress. As a geological factor denudation is of high importance in estimating change, and it must have been of yet higher importance in the earlier periods of the earth. The work done by moving water can only be imagined in part by bringing into prominence the fact that not less than thirty miles of sedimentary rocks are said to have been deposited from the beginning of the Azoic era to the close of the Tertiary. But from whence came so much material?

The average height of the land-surface of the earth at the present time is not more than 2,500ft., or less than half a mile, so that the thickness of the sedimentary rocks, as estimated

by leading geologists, exceeds the average height of the land-surface by not less than sixty times. These sedimentary deposits have been removed, principally by the agency of water, from some place where they were *in situ*, just as rocks are now removed by means of denudation from a higher to a lower level. Denudation is a necessary condition of inequality of surface when acted on by physical agents. The greater the instability of rock-masses the more certain is the prospect of denudation, for every physical agent acts in breaking down rocks and bringing them to one common level. But, recognising all this, is it possible to formulate a standard for the measurement of past time by an assumed standard of denudation which, the world over, must vary according to the character of the deposits composing every river-basin, in conjunction with its specialised climatic conditions?

As a test of actual change now in progress a knowledge of the amount of material borne by rivers to the sea is of high scientific value, and the results obtained by actual experiment give some idea as to the prospects to come. But even here the knowledge is of relative value only, for rivers, like everything else in nature, differentiate; they have a beginning, they undergo change, attain their maximum of development, and in course of time they disappear. Every river in Hawke's Bay affords evidence of the truth of this statement, and every tributary is an illustration of the surface-changes in progress, and of the differentiations which rivers undergo during the course of their history. The index of denudation of those rivers where experiments have been made shows wide variations, as is seen in the case of the Danube and the Po in Europe. The basin of the Danube is said to be lowered at the rate of one foot in 6,846 years, and that of the Po one foot in 729 years; but these rates have varied, and must have varied, ever since the rivers first began to flow. The elevation of the Po and Danube in their upper course, where denudation is always most powerful, would largely increase their effective power for transport of denuded material; and a similar remark applies to every river on the earth's surface. The increase in the denuding-power of moving water varies, according to Hopkins, as the sixth power of the velocity of the current; so that by simply doubling the rate of flow in a river its effective carrying-power is increased to no less than sixty-four times, and if trebled its power is increased 729 times. And every geologist must recognise the importance of this varying power in estimating surface-changes as brought about by the action of moving water. For years my attention has been directed to this aspect of geological inquiry, and it has always appeared to me that the plan of estimating the amount of material

carried by a few rivers to the sea and taking this as the index-standard by which to provide a time-measure for estimating the age of the earth is by no means satisfactory. No account appears to have been taken of the power of ice as a denuding factor within the arctic regions, and, as far as I am aware, no one has ever attempted to glean information as to breakaways and land-slips which take place within specified areas. Both of these are aspects of denudation which cannot be overlooked in formulating an index of past time as estimated in terms of denudation. The lowering of a river-basin necessarily modifies the rate of flow, and the carrying capacity varies in proportion to the lowering of the basin by means of land-movements of all kinds. The east-coast district of this island extending from Cape Turnagain to East Cape, a distance of about three hundred miles, will illustrate what I mean.

This district is bounded towards the west by the Ruahine and Raukumaru Mountain-ranges, and embraces an area of 8,970 square miles, or 5,740,800 acres. The counties included within this area are Patangata, Waipawa, Hawke's Bay, Wairoa, Cook, and Waiapu. The land is mostly hilly, and the rocks abutting on the sea-coast belong mainly to the Later Secondary and the Older Tertiary formations, and are made of stiff blue clays, marls, sandstones, with here and there indurated limestones. In the interior the rocks belong to the Younger Tertiary group—shingle, grits, clays, and limestones predominating. The average rainfall for the whole district is about 40in., being less along the coast than towards the uplands in the west. The rainfall, however, is a varying quantity, and appears to increase and decrease in regularly-recurring cycles of from six to nine years. Thus, in 1866 there was a deficiency of rainfall in the district of 7·2in.; in 1872, or six years later, the deficiency was 13·32in.; in 1878, or six years later, the deficiency rose to 16·16in.; and in 1886–87, or eight years later, the deficiency was actually 20·26in. The years of diminished rainfall were followed by years in excess of the average, some years showing a large increase, whilst others approached the normal standard. In 1892 the average rainfall was more than reached, but in the two succeeding years the rainfall exceeded all previous records, more particularly in 1893, when more than 60in. of rain fell over the entire district. Now, 40in. of rainfall spread over the district under notice represents 5·6 cubic miles of water. This water disappears from the land by river-drainage, by percolation, by evaporation, and by the demands of vegetation. During years of shortage the rainfall was diminished by one-third the normal quantity, which means that about 3·7 cubic miles of water fell instead of 5·6 miles. In years of excess the quantity was

increased by one-third; or, in other words, the rainfall was increased to 7·5 cubic miles. The difference between 3·7 cubic miles and 7·5 cubic miles is very great, and wide differences must be expected in the denuding effects which each quantity of water is likely to produce when spread over the same area.

But even an excessive rainfall may be so distributed as to time that its effects as a denuding power are but slightly greater than under what may be termed normal conditions. As pointed out above, it is the intensity of flow, or of movement, that produces unusual denuding effects, and this is well shown by the effects of the floods which took place in this district in December and January, 1893–94. When going over the district shortly after the floods had taken place, I was surprised to find how much the appearance of the country had changed. Thousands of breakaways or slips were to be seen, some of them of large extent; and I was impressed with the absolute necessity of keeping a record of surface-changes such as had been produced not so much by an excessive rainfall as by a heavy continuous downpour at a time when the surface of the country was saturated. I had traversed the district for sixteen years, but, although occasional large slips had been met with, there had been nothing to approach the marvellous changes in 1893–94, which showed in the completest manner how largely a district may have its surface-features modified by a rainfall which represents only a slight deviation from the normal conditions of that district. As I did not see how to obtain the necessary information concerning the changes brought about in so extensive a district without a heavy expenditure of time such as I was unable to afford, I communicated with Sir James Hector, the head of our New Zealand Geological Department, and he very kindly offered to obtain from the settlers such information as I might deem necessary for the purpose of my inquiry. Subsequently a circular letter was issued by Sir James, as follows: "For the purpose of keeping a record of the destructive landslips which took place along the east coast of the North Island during the years 1893–94, holders of land will oblige by filling in the queries given below, and returning the paper at the earliest opportunity: 1. County and locality. 2. Owner. 3. Area and situation of land. 4. What area do you estimate slipped away at the period named? 5. Do you remember any similar period when slips were as numerous? 6. Give rock-materials—*i.e.*, whether clays, sands, or hard rock." It was manifestly impossible to send a letter to every settler throughout the district irrespective of the area of land occupied, and only large holders were communicated with. In the majority of cases the queries have been answered; and I wish here to express my thanks and obligations to Sir James Hector for the

valuable help he has rendered me in this matter. The summarised results will be found at the end of this paper, and I am satisfied that in years to come they will be found of great public and scientific value. As far as I am aware, they constitute the only reliable data dealing with surface-denudation as the result of excessive rainfall, and they provide likewise unmistakable evidence that denudation as estimated by the material held in suspension and carried by certain rivers is by no means a true index of the time which has gone by since rock-materials began to differentiate as sedimentary deposits.

For the purpose of easy reference the results are classed under three heads: 1st, occupiers in the Counties of Patangata and Waipawa; 2nd, occupiers in Hawke's Bay; 3rd, occupiers in Wairoa and Cook *cum* Waiapu.

As already pointed out, the total area of the district is about five and three-quarter millions of acres, but this includes mountain-tops, forest-lands, and large areas still in the possession of the natives and from which no returns are available. Answers have been received from owners representing 1,158,237 acres, and from these sufficient information is available to show the extent of the denudation in a number of important river-basins. In some cases the owners omit to give an estimate of the area of slips on their lands, although they point out their frequency and the alterations they have caused by filling up creeks and modifying waterways. Thus, the Hon. J. D. Ormond writes, "Slips everywhere; the banks of creeks especially have slipped badly, but it is hard to estimate the acreage." Mr. Rechab Harding, of Mount Vernon, says, "Some of the hills appear to have been filled with water like sponge, whilst their bases have been enlarged and their heights lowered." Sir George Whitmore says of his property at Tuparoa, County Waiapu, "Cannot furnish a reliable estimate. At one spot the coast for quite half a mile has moved towards the sea." Mr. Arthur Harding, of the Kereru, writes that he has resided in his present district for sixteen years, and has never known anything approaching the extent of destruction. "It is impossible," he continues, "to estimate the damage done, but I have never seen one-quarter of the slips during the whole time I have resided in the district." Mr. Moore, of Waimarama, south of Cape Kidnappers, says in a note, "It is impossible to say the extent of the slips in this district, as the whole coast for fifteen miles on this run appears to be on the move. In some instances hundreds of thousands of tons have come down, blocking the beach up, but the sea washes the clay away very quickly. These large slips came down in December, 1893, when the creeks were higher than has ever been known by the oldest Maoris."

In answer to question No. 5, "Do you remember any

similar period when slips were as numerous?" the replies are emphatic and decisive. Several of the settlers refer to the heavy rainfall that took place on certain days. Thus, Mr. Gray, of Waiohika, Poverty Bay, says, "The rainfall at Waiohika measured over 15·36in. from 6 a.m. on 17th June to 6 a.m. on 19th June, sometimes falling at the rate of 0·7in. per hour." Mr. W. H. Smith, of Petane, noticed a similar downpour in December, when 3in. of rain fell in five hours, 5·49in. in ten hours, and 6·30in. in nineteen consecutive hours. It is when rains like these take place over a district that denudation becomes so marked and often disastrous, as in the case of the Hawke's Bay floods in December, 1893; and most of the slips along the East Coast appear to have taken place at this period of unusual rainfall.

The total estimate of slips for an area of 1,158,237 acres is 7,693 acres: this is exclusive of the "slips everywhere" which are said to have taken place on certain lands where estimates are not given. The estimates given here amount to 0·66 per cent. of all the land from which returns have been received. In some districts the slips or breakaways appear to have been unusually large. Thus, Mr. George Ormond, on Te Mahia, facing Hawke's Bay, estimates that 500 acres in a block of 5,000 acres have slipped away. Mr. Woodbine Johnson, of Maraetaha, Poverty Bay, estimates his slips at 1,500 acres out of a total area of 11,500 acres, or more than 13 per cent. of the whole. But even this estimate is exceeded in the case of Mr. Gray, of Waiohika, who estimates that 15 per cent. of his land slipped away in one property of his containing 2,200 acres, and which was improved grass-land. Open and improved country appears to have suffered most and bush country least. I have seen some of the extraordinary results of the slips on Mr. Gray's land at Waiohika. In one case a whole hill-side, some hundreds of feet in height, broke away, crossed a creek at its foot, filled an adjoining valley, and passed over a public road on the opposite side. The impetus was such that huge boulder-like rocks were lodged on the adjacent hill-side. In a few years all traces of this immense breakaway will have disappeared, and some geologist may even suggest that the perched blocks were lodged on the hill-side by means of glaciers. But glacial action is not needed to account for the transference of such blocks, for the degradation of the land is constant, and is much more influenced by water than ice; and this was truer in the earlier periods of sedimentation than now.

The large area which is shown to have broken away within a specified district will enable us to understand some of the effects produced on the earth's surface by a rainfall somewhat in excess of the annual average. But let it be assumed that the abnormal rainfall became the average rainfall over the district,

and then observe the rapidity with which denudation would proceed. The average annual rainfall for the district aggregates 5·6 cubic miles of water for distribution. This quantity would be increased to 7·5 cubic miles, as it was in 1893–94, when disastrous floods and breakaways occurred. If we assume that one-third of the total rainfall is carried back to the ocean by streams and rivers, then the carrying capacity of the rivers is represented by 1·9 cubic miles. This quantity was increased to 2·5 cubic miles in 1893. The amount of sedimentary matter held in suspension by the rivers varies very much according to the time of the year. In winter it is greatest, in summer least, in what may be termed normal conditions of flood; but in times of heavy flood the quantity of material suspended in the water is much increased. In some cases I have observed along the coast quite one-twentieth of the whole stream made up of earthy matter, but the instances are local and rare; and from numerous experiments carried on by me in the case of the river-waters of the Tutaekuri and Ngaururoro I conclude that, taking the three periods, winter, summer, and flood, into account, not less than 1 in 450 parts by volume of all the river-waters in this district consists of organic and inorganic matter held either in suspension or solution. On this estimate there is annually carried to the sea by our rivers 0·004 of a cubic mile of denuded earth; or, in other words, one cubic mile of the surface is carried away by the rivers and deposited in the sea in 250 years. The average height of the land throughout the district is certainly not more than 900ft., so that the 8,970 square miles which it embraces contain 1,530 cubic miles of land above sea-level, and which is available for denudation. Assuming the same rate of river-denudation as is now in progress, it will take on this estimate 382,500 years to plane down the land to sea-level and bring about conditions when the circulation of water in the land would be impossible by means of rivers. I have purposely worked out this case to show how useless as a geological index of time it would be to apply the known rate of denudation by means of our rivers to the age of the earth, in the face of the changes —the surface-changes—which are shown to have taken place over this district, and which are altogether independent of river-denudation. The 7,693 acres of breakaways, in a total area of 1,158,237 acres, represents 0·66 of an acre per cent., and if the average movement of each slip is only 50ft. the lowering of the entire district amounts to over 4in. As the entire area of the district under notice contains 5,740,800 acres, I do not think the estimate is overdrawn by naming 20,000 acres as having slipped away during the period of 1893–94, or an area which represents the lowering of the land by not less than 12in. To this must be added the enormous denudation which is constantly proceeding along the coast,

there being a glacier-like movement of the rocks seaward for not less than a hundred miles between the East Cape and Turnagain.

These modifying results of denudation are to be met with everywhere, and operating more or less under all conditions and climes. River-basins become lowered, the rate of flow and the power of carriage are diminished, new basins are formed, and these in combination with the varying character of climate make it impossible to accept results depending upon so many complex and modifying causes in estimating the past age of the earth and as a standard measure of denudation in past time. We are certain that long periods of time must have gone by to bring about changes of the earth's surface and the differentiations in the flora and fauna such as are recorded in the rocks themselves; but whether the years are to be reckoned by tens of thousands, hundreds of thousands, or by millions there is no means of knowing. No matter how we strive to arrive at a correct index of geological time the difficulties are the same. The animal equally with the vegetable kingdom has reached a complex—indeed, a highly complex—period of differentiation; but this differentiation has not been brought about by corresponding differentiations of the earth's surface, acted on as it has been from the beginning by forces all of which primarily depend on the sun for their activity and effectiveness. The world has grown from the simple to the complex by ever-changing and ever-modifying conditions. Every to-day differs essentially from its yesterday; and, although we know that animals and plants have come down through the ages by a constant advance in adaptation and specialisation, it cannot be asserted what conditions prevailed in times past to produce all those earth-changes without which changes in the flora and fauna were impossible. One thing, however, is certain: that time cannot be measured by river-denudation, and the estimates given by Houghton and others as to the time necessary for the deposition of the sedimentary rocks are just as uncertain and unsatisfactory as the estimates which the physicists and mathematicians have given us. The facts relating to surface-denudation which appear below supply evidence of rapid changes of surface irrespective of river-denudation, and the time will no doubt come when similar facts will be collated for other areas and countries. Such facts, however, whilst they supply valuable information to the geologists as to surface-changes now in progress, and to the possibility of great changes when physical conditions deviate but slightly from what may be termed the normal standard, cannot supply a reliable factor in the determination of geological time, any more than the inferences to be drawn from denudation by rivers, whether European, Asiatic, or other.

NTIES.—Square miles, 1,091; acreage, 1,216,640.

| | Acres. | | Estimated Slips. | Similar Period. | Rock-materials. |
|---|---|---|---|---|---|
| J. Rhodes .. . | 7,000 | Ruataniwha .. | 1 acre | No .. .. | Yellow clay with shingle. |
| A. Carlyon .. . | 10,000 | Ruataniwha .. | 2 " | No .. .. | Yellow clay with shingle. |
| John Harding . | 15,000 | Ruataniwha .. | 15 " | In 1867 (June) almost similar | Limestone and chalk marls. |
| J. Cowper and Knight. | 16,000 | Left bank Manawatu | 10 " | No .. .. | Limestone, papa, and clay. |
| J. and F. Holden . | 12,000 | Ruataniwha and Waimate | 20 " | No .. .. | Shingle and clays. |
| F. J. Tiffen .. . | 7,000 | Oero, Patangata .. | Minor slips | Yes .. .. | Clay on papa. |
| Archdeacon S. William | 38,000 | Patangata .. | 280 acres | In 1878 (Mangakuri) | Limestone, clay, and papa. |
| Bank of New Zealand. | 31,000 | Mangakuri, Danevirke | 30 " | No .. .. | Clay on papa, and shingle. |
| Trustees C. J. Nairn . | 26,000 | Pourere .. .. | 30 " | Never .. .. | Clays on papa and limestone. |
| J. Speedy .. . | 4,000 | Wainui .. .. | 5 " | No .. .. | Clay and papa. |
| J. D. Ormond . | 30,000 | Wallingford .. | Cannot estimate | (See *ante.*) In 1878–79, bad | Clay and marls. |
| R. S. Curling.. . | 15,000 | Oero, Patangata .. | 60 acres | No .. .. | Limestone, sandstone, and papa. |
| G. and P. Hunter . | 30,000 | Porangahau | 300 " | No .. .. | Clay and limestone. |
| Beetham Brothers . | 14,300 | Patangata, 10 miles coast | 1,000 " | No .. .. | Blue clay (papa) and limestone. |
| St. Hill Brothers . | 29,000 | Near Cape Turnagain, sea-coast | 400 " | No .. .. | A papa clay. |
| | 284,300 | | | | |

HAWKE'S BAY COUNTY.—Square miles, 3,232; acreage, 2,068,480.

| Owner. | Area. | Position. | Estimated Slips. | Similar Period. | Rock-materials. |
|---|---|---|---|---|---|
| | acres. | | | | |
| N. E. Beamish | 19,000 | 25 miles west of Napier | 50 acres | Never | Chiefly limestone and papa clays. |
| John Chambers | 7,000 | Havelock Riding | 75 „ | No | Clays and papa. |
| Meinertzhagen and Moore | 35,000 | South of Cape Kidnappers | (See *ante*) | No | Blue marl or papa. |
| J. B. Chambers | 5,500 | Havelock Riding | 6 acres | Not for many years | Hard clays and limestone. |
| W. Heslop's trustees | 5,000 | Pukatapu | Numerous | No | Black soil (?), clays, and limestone. |
| H. S. Tiffen | 2,400 | Taradale | None | No | Limestone. |
| Thomas Tanner | 16,700 | Havelock-Petane | 18 acres | No | Tertiary limestone. |
| Arthur Harding | 32,000 | Kereru | 160 „ | No | Clay and slate. |
| A. and W. Birch | 115,000 | Eweburn | .. | .. | Limestone and slate. |
| Russell Brothers | 30,000 | .. | .. | .. | Limestone and shingle. |
| Hugh Campbell | 13,000 | Te Aute district | 20 acres | Approached in 1883-84 | Limestone and papa. |
| Thomas Hallett | 33,500 | Puketitiri | 4 „ | No | Limestone, clays, and conglomerates. |
| T. H. Lowry | 14,700 | 20 miles west of Napier | 25 „ | No | Clays. |
| A. Sheild | 16,000 | Waikonini | 40 „ | 22 years. No | Papa; little limestone. |
| W. Shrimpton | 14,123 | Matapiro | 3 „ | No | Mostly limestone. |
| John Bennett | 7,000 | Puketapu | None | No | Mostly limestone. |
| Maurice Mason | 2,000 | Heretaunga Riding | 10 acres | 20 years. No | Limestone and hard sandstone. |
| John Studholme | 200,000 | Rangitikei-Owhaoko | Unable to say | In November, 1872 | Papa, limestone, and blue rock. |
| Gordon and Moore | 28,000 | Mangaharuru | 100 acres | No | Clays and sands. |
| Thomas E. Gordon | 13,314 | Kidnappers | Extensive | No | Conglomerate and loess. |
| | 639,237 | | 511 acres | | |

Wairoa, Cook, *cum* Waiapu Counties.—Square miles, 3,837; acreage, 2,455,680.

| | Area. | Position. | Estimated Slips. | Similar Period. | Rock-materials. |
|---|---|---|---|---|---|
| | Acres. | | | | |
| J. McKinnon .. .. | 15,000 | Moaeangiangi .. .. | Numerous | Always slips; wet ground | Limestone. |
| H. Twigg .. .. | 4,600 | Moaeangiangi .. .. | 20 acres | No; for 30 years | Limestone and papa. |
| John Cowper .. .. | 8,500 | Frasertown .. .. | 200 " (less than neighbour's) | No: for 20 years | Sands, clays, and limestone. |
| Niel Walker .. .. | 16,000 | Wairoa .. .. | 100 acres | No .. .. | Clay and papa, with sand. |
| George Ormond .. .. | 13,000 | Te Mahia .. .. | 500 " | Slips in 1880, or thereabouts | Clay and papa. |
| W. Elliott .. .. | 12,300 | Frasertown .. .. | 300 " | April, 1892 .. | Clay marls. |
| J. Hunter Brown .. .. | 18,000 | Whakaki, Wairoa .. | 200 " | No .. .. | Clay, limestone, and papa. |
| James Macandrew .. | 25,000 | Waikare–Wairoa .. | 70 " | No .. .. | Clay and papa. |
| Guthrie-Smith and Stuart .. | 20,000 | Tutira Lake .. .. | 1,000 " | 10 years ago many slips | Clays and limestone. |
| James Woodbine Johnson .. | 11,500 | Nick's Head .. .. | 1,500 " | No; bad in 1880 | Papa rock. |
| Walter Withered .. .. | 4,400 | Waikohu Bay .. .. | 30 " | Never .. | Papa. |
| P. Baker .. .. | 4,000 | Near Gisborne .. .. | 200 " | No; for 16 years | Clay and papa. |
| G. S. Whitmore .. .. | 20,000 | Tuparoa, East Coast .. | (See *ante*) | Some previous large slips—1883–88 | Clays. |
| H. H. Wall .. .. | 5,000 | Patutahi .. .. | 3 acres | No .. .. | Clay and sands. |
| Charles Seymour .. .. | 21,500 | Whangara .. .. | 150 " | No; for 14 years | Papa and sands. |
| Charles Gray .. .. | 6,600 | Waimata–Waikohu .. | 550 " | (See *ante*) .. | Clays and coarse limestone. |
| Ewen Jamieson .. .. | 1,000 | Upper Patutahi .. | 200 " | No; for 25 years | Clay and papa. |
| M. Hutchison .. .. | 17,000 | Waikohu .. .. | None | .. | Papa and sandstone. |
| W. Morice .. .. | 10,300 | 25 miles west of Gisborne | No estimate | Yes; in 1876 .. | Papa and sandstone. |
| G. Scott .. .. .. | 1,500 | 15 miles west of Gisborne | 6 acres | No; for 29 years | Soft papa. |
| Totals .. .. | 234,700 | | 5,029 acres | | |

Summary.—1. Waipawa *cum* Patangata: Acres returned, 284,300; slips, 2,153 acres. 2. Hawke's Bay: Acres returned, 639,237; slips, 511 acres. 3. Wairoa and Cook: Acres returned, 234,700; slips, 5,029 acres. Total acres returned, 1,158,237; slips, 7,693 acres = 1 acre slipped in each 150 acres, or 0·66 of an acre per 100 acres.

## ART. LXXI.—*Ruapehu and the Volcanic Zone in 1895: No. IV.*

By H. HILL, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 15th July, 1895.*]

THE eruption of Ruapehu on the 10th March of this year has opened up an interesting question as to what is likely to be the future of this mountain: Is it to become dormant and finally extinct, or will it be seen again as an active volcano similar to what it was in times which may be counted by the century? The last time when the mountain displayed signs of increasing activity was on the 1st May, 1889. It is only within the last decade that Ruapehu has come to be looked upon as a mountain whose life is not yet over. Tongariro and Ngauruhoe were known to be active volcanoes, because clouds of steam could be seen rising from them at a distance of fifty miles in the direction of Taupo and the Kaingaroa Plains. When Hochstetter, the famous geologist, was at Tokaanu in 1859 he appears to have made the fullest inquiries from the natives concerning the volcanic group to the southward, although he was forbidden to visit or even to approach any portion of the group. Bidwill and Dyson, in 1839 and 1851 respectively, had secretly visited portions of the group, and their published accounts had no doubt fired Hochstetter with a desire to see what was, at that time, looked upon as the only spot where volcanic phenomena could be studied on a large scale in this country. Of Ruapehu, however, nothing was then known, except that native tradition said it was the abode of an evil spirit, Te Ririo, who caused men and women to wander hither and thither over the mountain until bereft of their reason. The fearsome and solitary surroundings in the eyes of an imaginative people caused this mountain to be viewed with awe and dread, and nothing was remembered concerning it beyond the fact that it was the abode of an energy or a cause which brought about injury to humankind. Does this not suggest that the mountain was a centre of danger owing to the frequency of explosion? Hochstetter says, in his great work on New Zealand, page 378, "No one has ever ascended Ruapehu or explored it. Nevertheless, there can be no doubt as to its volcanic nature; but it seems perfectly extinct—there is no trace of a solfatara to be discovered in the distance either at its sides or at the top, and it is totally unknown whether the broad summit forms a plateau or whether it contains a crater."

Between 1859 and 1880 no attempt seems to have been made to ascend any of the mountains that were held to be *tapu* by the Natives, and which included the whole of the volcanic group. In the latter year, however, Messrs. Maxwell and Beetham reached the south peak, known as Parae-te-tai-tonga. There they built a cairn and left several small coins as mementoes of their visit. Since, the mountain has been crossed on several occasions by Government surveyors and others, and the topography of the mountain is now fairly well known.

As pointed out by Hochstetter, the mountain is an enormous truncated cone, with ridges running for miles to the east, north, and south like the gnarled roots of an ancient forest-tree. Towards the south the mountain presents a much steeper face than to the north, east, or west. On the east the mountain is most broken and denuded, and has much smaller snowfields than are met with on the west and south-west. Long, sloping ridges occur here, and these actually form the water-parting between the rivers flowing to the north and south respectively. The forest-lands run close to the snow-line on the west and partly on the south; but only clumps of stunted *Fagus panax* and scrub are found along the east and north-east portion of the mountain. Ruapehu is separated from Ngauruhoe by a valley varying from a mile to two miles in width. The Tongariro group is situated within an area of desert and desolation, which, from its height in comparison with the surrounding area, may be likened to the top of an immense dome, which flattens in the direction of its rim. Here and there transverse corrugations appear to break the general arrangement, as in the case of the Kaimanawha and other smaller ranges; but these do not alter the dome-like structure which the North Island presents, with Ruapehu and Tongariro as a centre.

The country immediately surrounding the cones has a varying height from 4,800ft. to 3,000ft., and it is made up principally of pumice and lava-flows from the mountains. Here and there along the western side of the group are numerous conical hills made up of volcanic lavas, but having no crateral hollows or basins such as are usual in cones from which lava has issued; and it may be assumed that traces of lava-flows will be found along the whole line of country which separates Ruapehu and Egmont. On the east side of the group no such cones are found, and the country as far as the Kaimanawha Range is composed of a grit and pebble pumice mixed with coarse material of many rock varieties similar to what were found in the vicinity of Rotomahana soon after the eruption. The clinkers found on the Rangipo Desert in clumps here and there differ from all the volcanic material I have seen else-

where, and they suggest a partial fusing of pumice with a greenish-looking rock, but before the fusion was complete they were ejected from an orifice and fell on the desert where they are now to be found. Their partially-rounded surfaces imply cooling during their translation, and their freshness and position suggest their eruption from Ruapehu at a very recent date.

A reference to a map of the North Island will show the line of direction of what is known as the volcanic belt. This belt in a measure takes the form of an ellipse, with its major axis running north-east and south-west. The length of this axis is not less than 140 miles, whilst the minor axis extends about 75 miles in a north-west and south-east direction. Imagine a line drawn from the top of Ruapehu, at the south end of the major axis, at a height of 9,000ft., to the top of Whakaari or White Island, in the Bay of Plenty, 800ft., and you have a plane representing the slope of all the intervening cones between these two extremes. These include Ngauruhoe, Tongariro, Pihanga, Tauhara, Tarawera, and Edgecumbe. Including Ruapehu and Whakaari, five of the cones may be said to show signs of activity. The entire country included within this elliptic belt presents direct evidence of volcanic action. The surface is covered either with pumiceous deposits or with lavas of many grades and characters. The boundary of the belt is made up of mountainous country presenting a somewhat scarped face to the volcanic area, and suggesting either an elevation of the bounding rocks or a depression of the enclosing area. Numerous streams and rivers pass through the volcanic belt, and in most of the exposures I have seen trachytic lavas make their appearance, giving one the idea that the entire area is made up of lavas overlaid by pumice-washings and other kinds of volcanic ejectamenta.

On the Taupo Road, between Tarawera (Hawke's Bay) and Rununga, most of the exposures present trachytic lavas. In the bed of the Waipunga Stream, which crosses the Taupo Road at Rununga, the lavas form the bed, and strike across country in every direction. At the Rangitikei River, some twelve miles further on in the direction of Taupo, the same trachytic lavas are to be seen, and they continue along the Kaingaroa Plains, both in the direction of Galatea and the Waiotapu Valley. They surround Taupo Lake; they form the rocks exposed on the banks of the Waikato River from its exit at the lake as far as Ateamuri; they surround Lake Rotoaira, near Tongariro; and they continue along the west side of the volcanic group on to the Waimarino Plain.

Along the centre of this immense belt of trachytes, which covers the entire country like a large sheet, the volcanic cones

rise in the line representing its major axis. Hochstetter, in his geological map of the Auckland Province, shows the distribution of trachytic lavas to the west and north of Taupo Lake, but he appears to have thought that the lavas which surround Tauhara Mountain did not extend for any distance to the east or north-east; and it is very certain that he had no idea that volcanic rocks were to be found of any extent to the east and north-east, or that they struck through the island in the direction of Hicks Bay.

Hochstetter's opinion as to the sequence of volcanic phenomena is very suggestive. He says, "The first volcanic eruptions were submarine, consisting of vast quantities of trachytic lava, breccia, tuff, obsidian, and pumice-stone, which, flowing over the sea, formed an extensive submarine volcanic plateau. The volcanic action continuing, the whole mass was upheaved above the level of the sea, and new phenomena were developed. The eruptions going on in the air instead of under the sea, lofty cones of trachytic and phonolitic lava, of ashes, and cinders were gradually formed. These eruptions breaking through the original submarine layers of trachytic lava, breccia, and tuff, raised them, and left them as we now find them, forming a more or less regular belt round the central cones, and having a slight inclination from the centre outwards."

This theory assumes three periods of volcanic activity—First, submarine, with deposition of trachytic lavas; second, elevatory, when the whole of the submarine deposits were raised above sea-level; third, formation of cones. Unfortunately, Hochstetter does not suggest a time when the volcanic phenomena began, or what sedimentary rocks were contemporary with the elevation of volcanic ones. But the three periods agree well with the distribution of pumice through the rocks of this district.

In volume xx. of the Transactions, Article xxxix., there is a paper on "The Geological Distribution of Pumice along the East Coast," and three separate periods of deposition are shown to have taken place: 1st, a Miocene (?), Cretaceo-Tertiary of the Geological Survey; 2nd, a Pliocene; 3rd, a Recent. If the distribution of the pumice over the Island agrees with periods of activity, as stated by Hochstetter, then the Miocene (?) period was one when the North Island presented a few islands only in place of its present area. It was towards its close that the trachytic lava-flows welled up, as it were, without the formation of cones and spread themselves, as they have done, in such a curious manner over the whole of the volcanic belt. During the Pliocene period the North Island had grown considerably, and the pumice, with much of the *débris*, was spread over the district both east, north, and south by the

rearrangement of watersheds which then took place owing to differential movements of the land. Finally we arrive at the period of cone-formation; and undoubtedly a fresh period of volcanic activity began as the result of earth-movements almost parallel to and on both sides of the major axis of the volcanic zone. How long the activity of the cones along the major axis has continued it is impossible to say; and it is equally uncertain whether the building-up of these began from the south or the north. The extinct Egmont and the equally extinct Hauhangatahi to the westward of Ruapehu almost imply that these mountains were two of the earlier cones, as from their size compared with all except Ruapehu they would require a longer interval of time to cool. In any case, the third period of activity has been more manifest in the southern portion of the zone than elsewhere, and the activity is still greater there than in any other portion of the Island. Ngauruhoe is no doubt the youngest of the volcanic cones, as its marvellous symmetry has not yet been broken down like Tongariro and Ruapehu by the lapse of time and atmospheric influence. Tongariro and Ruapehu are less active than Ngauruhoe, and there can be little doubt that the two former are in a state of collapse. Ruapehu appears, like Tongariro, to have periods of activity depending on hydrothermal causes. The changes which took place at Te Mari, situated at the north end of Tongariro, in November, 1892, correspond exactly with those which have taken place on Ruapehu—first in May, 1887, and again in March of this year.

At the summit of Ruapehu is a crater-lake, situated between the three highest peaks, known as Parae-te-tai-tonga to the south, Ruapehu to the west, and Te Heuheu to the north. This crater-lake on its western half is surrounded by glacial ice, which, as the terminal portion of a glacier, actually forms the walls of a sometimes boiling crater. It has hitherto been impossible to learn the depth of the water in the crater, but its temperature appears to undergo important changes, depending possibly on the supply of ice from the mountain. Observers who have seen this crateral lake report it either as being partially frozen over, as being cool, as being warm, or as being in a state of ebullition. When visited by me in March, 1890, its waters were boiling rapidly, and there was a wave-like movement from west to east, whilst at intervals of about two minutes steam was suddenly thrown from the surface, and a kind of pulsating movement followed, the waters appearing to subside for a short space. There appeared to be little or no space available whereon to stand, assuming it had been possible to reach the lake, except at the south-east bend; and, as the crater-walls at this point were steaming furiously, and our party had no rope available, no attempt was made to

reach the lake. I am pleased to find that this has now been accomplished by Mr. Walter H. Dunnage, of the Survey Department, with two of his men. Mr. Dunnage has made the ascent of the mountain on several former occasions, and when visited by him at Easter last year (1894) the "lake was of a beautiful green colour, apparently cold, with a sulphurous deposit on the surface here and there." This had all changed on the 5th of April of the present year, when "the lake was of a milky colour, with steam rising from its surface, and surrounded on all sides but the east by a beach from half a chain to a chain in width." The lake was 10ft. or 12ft. lower than he had seen it before, and, what was the most fortunate thing of all, the party of three were able, with due precaution, to reach the margin of the lake—the first human beings who had ever done so. The temperature of the lake was found to be 128°. "The margin of the water was covered with blocks of very friable scoria, among which were innumerable small boiling springs causing a dull, weird sound." This visit was made about a month after the explosion which took place on the 10th of March, when a column of steam was thrown up at least 1,000ft. above the crater; and the same thing was observed on several succeeding days.

It does not appear from Mr. Dunnage's account that there was any trace on the mountain of material, such as mud and boulders, having been ejected from the crater and deposited on the snowfields, but it would seem from the lowness of the water that most of it must have been sent out by the several explosions. Mr. Dunnage suggests that the River Wangaehu issues from the crater, but in this he is mistaken, as I have followed this river to its source, the discoloured stream coming from the ice immediately below the rocks known as "The Pinnacles" to the north of the crater.

The discovery of other warm springs, seemingly large *puias*, on the western side of the mountain is an event which adds interest to the mountain, and points to "sores," similar to those found at Ketetahi and other places along the slopes of Tongariro. But both mountains have had their day. They present phenomena which may be termed the condition intermediate between activity and repose. It is a warring between heat and cold; and those who have ever sat down within a volcanic area capped with glacial ice and snow can have no doubt as to the victor. Ruapehu has had, and will have for some time to come, periods of activity due to hydrothermal causes; but everything testifies that its end, from a geological point of view, is near. Still, it is well to keep records of the changes taking place, for the gathering together of facts connected with volcanic phenomena will enable us to arrive at those generalisations by which volcanic phenomena

can be foretold with as much certainty as a study of meteorology enables us to say what kind of weather to-morrow is likely to be. Ruapehu, although capped with ice for a thousand feet or more, is a festering sore—a solfatara—whose symptoms imply decay and extinction. On various parts of the mountain, as in the case of Tongariro, there are traces of thermal activity, and, when the topography of the mountain comes to be better known, no doubt many hot springs and mud-holes will be found similar to those reported by Mr. Dunnage and party as existing on the west side of the mountain. It may be that a supplementary crater will be found on the western side; but we must wait for further exploration before it can be ascertained with certainty that the mountain "broke out," like Tongariro, in places outside, and at a much lower elevation than the original crater. A mountain like Ruapehu, with its enormous ridges and spurs, can hardly have been formed by means of its present limited crater, and mighty changes must have taken place since the time when the crater was imbedded within the three peaks which now bound it on three sides.

There are no traces of marine beds in the vicinity of the trachytic lava, nor is there evidence in the tuffs of having been raised from below the sea. The limestones, which present bold scarps to the volcanic area along the south-east portion of the district, and, indeed, are traceable on the borderland in every place visited by me, even to the north-west in the direction of Lichfield, belong to the later Tertiaries, and it would seem that the elevation of the volcanic area did not reach its present dimensions till nearing the close of the Pliocene period. This extension of the trachytic area appears to have given rise to the formation of an immense lake, which included the whole of the Taupo plateau, and this continued to enlarge until the increase of volcanic activity along the present line of weakness caused modifications to take place in the watershed of the Island, such as have brought about the present conditions. It is needless to point out the abundant evidence in support of this statement, as further details must be left for another paper.

What the future of Ruapehu and the other volcanic cones will be cannot be predicted with any degree of certainty. Egmont is extinct, Pihanga and Tauhara are also extinct, and the activity of Ruapehu, Tongariro, Tarawera, and Edgecumbe is comparatively unimportant. Of Ngauruhoe the case is different; and I shall conclude by quoting what Hochstetter says of this beautiful and symmetrical cone: "Although this grand volcano, with its various craters, has, within the last centuries, as far as it is known, not had any eruption of lava, yet I would not venture to assert that such might not suddenly

recur again." Ngauruhoe has within late years poured forth streams of lava from its crater, and it may be that this is the best sign of diminishing activity in the case of Ruapehu and Tongariro, its elevation being much more recent than either of these great truncated cones.

## V.—CHEMISTRY.

### Art. LXXII.—*Iron from the Titaniferous Sand of New Zealand.*

By E. Purser.

Communicated by T. H. Hustwick.

*[Read before the Wellington Philosophical Society, 18th December, 1895.]*

At starting Mr. Purser desires me to say that until about three years ago the author had no special knowledge of the subject of this paper, but about that time he conceived the idea of separating the refractory from the metallic portion of the sand by magnetism and then forming it into a hard briquette suitable for the smelting-furnace. He asks that you will make due allowance from a scientific point of view when discussing this paper, he relying more on a practical direction.

Mr. Purser says the component parts of the titaniferous sand that is found in such enormous quantities on the west coast of the North Island consist of magnetic oxide, titanium, olivine, and silica, the most refractory of which is titanium. The proportion of magnetic oxide varies according to the local surroundings, that found in the vicinity of the Breakwater at New Plymouth being heavily charged with silica, which comes down from the surrounding hills of grey sand. The same drawback is also found at Waitara, and many other parts of the Taranaki District; while the richest deposits are generally found at the mouths of the rivers, and always on the north side of them. The best deposits the author has observed are at the Waiwaki, in Taranaki Province, and the Awakino and Mokau Rivers, in Auckland Province. On the north shores of these rivers there is practically an unlimited supply of very rich sand, which averages about 88 to 90 per cent. of magnetite; and equally good sand has frequently been found in thick layers far inland whilst well-sinking. The origin of these deposits is to a certain extent shrouded in mystery; in all probability Mount Egmont was the parent of them, and those found as far north as Onehunga and Kaipara have probably been carried in that direction by sea-currents.

The object of the author's invention is to eliminate all the refractory constituents of the sand by magnetism, and to make the cleaned portion up into a hard briquette suitable for the smelting-furnace. He also claims that the product made from separated sand is far superior and more malleable than it would otherwise be if the titanium was fused with the magnetite, in which case titanic acid would be absorbed in the iron and be nearly as potent in producing "red short" as phosphorus; while some of the specimens laid before you this evening, made from separated sand, are comparatively malleable, even although they have not been puddled or treated by any second process whatever.

*Separation.*—This is accomplished by passing the sand underneath magnetized drums; and the author thinks it prudent, in order to avoid complications, to embrace the two principles of magnetism—namely, electro and permanent. The electro-magnet is made with equal sections of magnetized skins and insulation alternately, and is so arranged that at each quarter-revolution the current is broken and discharges the magnetic sand accumulated; while in the permanent magnet-drum its periphery comes in contact with a fixed brush, which sweeps the sand into a receptacle provided for it: but, as the author is in attendance with drawings and the means of practically demonstrating the process, it is needless that I should take up the time of the meeting by attempting to describe it.

*The Briquette.*—As it is impossible to smelt loose sand in a blast or cupola furnace, it becomes necessary to put it into some solid form in order that it may be subjected to the fullest possible action of the fuel, and also stand the weight of the furnace during fusion. This is accomplished by mixing the separated sand with a glutinous substance made to the strength of ordinary size, of about one part of ordinary carpenters' glue to twenty-two parts of water. Even when using the glue of commerce this would not be an expensive article, as it takes a very small quantity to saturate a large body of sand; but this cost is further reduced by making the size from the waste by-products of the butcher's slaughterhouses. After being well mixed it is spread on sheets of iron to the thickness of ½in., and blocked out into oblong briquettes about 5in. by 3in. These are then dried with a gentle heat for about thirty minutes, when they become perfectly hard and are ready for the smelting-furnace. It is further claimed that by the use of this glutinous organic substance for binding the sand a double object is attained—that of becoming a supplier of animal charcoal in one direction and of carbonic oxide in another; in fact, it acts as a very useful flux, which greatly assists conversion. The total cost of the finished

briquette is estimated at 3s. 3d. per ton, including separation of the sand; and 1 ton of good fuel will smelt 8 tons of them.

These briquettes smelt as readily in a cupola furnace as ordinary pig-iron does, and with the same amount of fuel as previously stated; while the proportion of slag is only slightly in excess of that found in remelting pig-iron, or at the outside 25 per cent. This very low percentage is not to be wondered at when it is remembered that all extraneous matter has been eliminated from the sand by separation, and the glutinous substance used in making the briquette has all the cleansing properties of a flux. The author considers that, while separation is necessary in order to produce malleable iron, this briquette is really the key to the position for producing the highest class of metal at (as will be shown later on) the lowest cost of any iron-producing country known.

This is saying a good deal; but it must be remembered how wonderfully Nature has endowed New Zealand with the richest of raw materials for the manufacture of iron, costing next to nothing to mine; and in this condensed form it is so easy to handle that New Zealand should not only supply her own wants, but at an early date (having in view the very superior quality) should soon become a large exporter, even to Europe itself.

*Cost of Production.*—It is quite anticipated, it will be granted, that the reduction of this ore is an easy matter, and that the product is superior to any iron on the market—in fact, from the low percentage of carbon and the high percentage of iron it is apparent that we have the raw material of steel lying at our feet; but the all-important question is, What will it cost to produce? The author has gone very carefully into this matter, and cannot make the cost per ton come to more than £1 10s., as follows:—

| | £ | s. | d. |
|---|---|---|---|
| Elevating the sand ... ... | 0 | 0 | 9 |
| Separating ... ... ... | 0 | 1 | 0 |
| Making briquettes ... ... | 0 | 1 | 6 |
| Labour ... ... ... ... | 0 | 6 | 7 |
| Fuel ... ... ... ... | 0 | 9 | 0 |
| Flux ... ... ... ... | 0 | 4 | 0 |
| Loss of weight ... ... ... | 0 | 5 | 0 |
| Interest on capital ... ... | 0 | 2 | 2 |
| | £1 | 10 | 0 |

This is probably lower than ordinary pig can be produced for in Europe, and, surprising as it may appear, it is still a fact, considering the advantages we have in the raw material

already referred to, as against the heavy work of mining the ordinary iron-ore of Europe. Then, also, outside calcining requires about 1 ton of coal to each ton of ore (in order to get rid of only a portion of the extraneous matter prior to its going into the furnace); and finally there is the handling of 3½ tons of ore, and, moreover, the consumption of fuel sufficient to fuse these 3½ tons in order to produce an output of 1 ton of pig-iron: while the balance, 2½ tons, until recently was not only absolutely valueless, but necessitated a still further expense for handling. Now, while the cost of fuel and labour in New Zealand is in advance of these items in Europe, this extra cost is more than counterbalanced by the richness of our oxide, and the production of a metal which, at its first stage, would probably fetch double the price of No. 1 pig, owing to its very superior quality.

## Analysis.

It will be seen by the following analysis that iron made from New Zealand sand is superior to even the highest quality known in Europe—viz., Swedish pig—being higher in the good elements and lower in the refractory ones:—

| (Sir Lowthian Bell.) *Swedish Pig-iron.* | | (Mr. Skey, Government Analyst, 14th April, 1895.) *New Zealand Iron.* | |
|---|---|---|---|
| Carbon | 4·50 | Carbon | 2·21 |
| Silicon | 0·50 | Silicon | 0·84 |
| Sulphur | 0·03 | Sulphur | Trace |
| Phosphorus | 0·15 | Phosphorus | 0·20 |
| Manganese | 1·80 | Titanium | 0·34 |
| Iron | 93·02 | Iron | 96·41 |
| | 100·00 | | 100·00 |

From another sample assayed on the 16th July, 1895, with a view to find what percentage of carbon was in combination and what quantity of titanium (if any), Mr. Skey reported: "The total quantity of carbon in the iron No. 6958 is 1·71, of which 1·34 is in combination with the iron. I found traces of titanium only."

It is further interesting to note that, while pig-iron made from New Zealand ironsand contains only about one-half the carbon found in the best brands of European manufacture, even a large percentage of this is in combination, as stated above, while the only other metal I can find carrying any carbon in combination is that used by Bessemer for making steel, which stands thus:—

$$\left.\begin{array}{ll}\text{Carbon combined} & 0{\cdot}50\\ \text{Carbon graphitic} & 3{\cdot}60\end{array}\right\} 4{\cdot}10$$

## PROSPECTS OF THE INDUSTRY.

By reference to the Statistics of New Zealand, page 171, 1893, it will be seen that the imports of certain descriptions of iron, the whole of which could be manufactured in New Zealand from the titanic ironsand at a much cheaper rate, were as follows:—

| | £ |
|---|---|
| Rails and railway-bolts ... ... | 48,037 |
| Pig-iron, wrought, wire, &c. ... | 358,511 |
| Nails ... ... ... ... | 24,773 |
| Steel and steel rails ... ... | 14,484 |
| | £445,805 |

Or, in other words, these items represent one-fourteenth of the entire imports of the colony for that year.

As an evidence of the easy manner in which the briquette melts, perhaps it would not be out of place if I were to submit a few certificates from ironfounders who have conducted experiments in small cupola furnaces.

The following are the results of practical trials that have been made with Mr. Purser's process:—

Blenheim, 20th February, 1895.

I smelted about 5cwt. of ironsand briquettes made under Mr. E. Purser's patent process on the 8th February. The mode of smelting was in a small cupola furnace; from the time of putting them in until they were melted was about twenty minutes; and the quantity of fuel requisite seemed similar to that used for smelting pig-iron.

I find that that portion of the briquettes which was run off in the time mentioned—viz., twenty minutes—the metal was not thoroughly converted, while the last charge, which I let down with the fuel by letting down the bottom of the furnace, and allowed to cool gradually, produced a malleable metal of very superior quality, much resembling mild steel.

WILLIAM FAIRWEATHER,
The Foundry, Blenheim.

New Plymouth, 16th April, 1895.

About 5cwt. of Mr. Purser's briquettes were made in my foundry, and afterwards smelted in my cupola furnace, with the following results: The briquettes smelt easily; they will flow in about thirty minutes, but at that stage it looks a great deal like slag, but by putting it through the furnace again a considerable quantity of iron was obtained, although it was not sufficiently liquid to flow freely. This was owing to the furnace being too short, and not giving the material sufficient time to absorb carbon. Fortunately, there was sufficient slag intermixed with the metal to allow it to be cut out, which was done as soon as the furnace was cool enough, and the following day it was cast into ingots, wheels, &c. The metal is very close-grained, and resembles very superior steel.

F. W. OKEY,
Taranaki Foundry.

Wellington, 19th June, 1895.

I assisted Mr. Purser when smelting a quantity of ironsand briquettes, made under his patent process, at Mr. Seager's foundry, Wellington. They smelt with great rapidity (the time being thirty-five minutes) in a small cupola furnace, and conversion takes place in about half an hour

after they reach the melting-point. Ran out castings of tools and ingots, but the rapidity (which is peculiar to steel) with which it cooled on the hearth of the furnace prevented utilising the whole of the product for casting purposes on that day. The metal is remarkably tough and very fine in the grain, and in my opinion it is a high-class steel.

J. Neal,
Smelter, Antimony Department of Mr. E. Seager,
Wellington.

In addition to these certificates Mr. Purser has made several other experiments, all of which confirm what can be successfully accomplished even under the disadvantage of having only a small cupola furnace and crucibles to work with; and it must be remembered that a cupola is not constructed on lines suitable (nor was it ever intended) to smelt ore, but manufactured iron, such, for instance, as scrap, cast, or pig, for making castings.

It will be seen that in these cases the briquettes flow from the tap-hole at from twenty to thirty minutes, according to the pressure of the blast; but in order to absorb sufficient carbonic oxide to come to complete conversion the liquefied mass must remain on the hearth of such a furnace for a further time before conversion takes place. Now, when it is remembered that the height of the cupola-furnaces used was only 10ft. from the twyers, and that an ordinary blast-furnace would be quite 40ft. high, it is absolutely clear that conversion would take place before the molten briquettes reached the hearth of this kind of furnace, practically from the greater length of time the charge would take in coming down a distance of 40ft. in a blast-furnace of that height, as against only 10ft. in a cupola.

In conclusion, if New Zealand is to become the great nation which nature intended her to be, by the rich endowments of mineral wealth, the time is none too soon when we should make a great effort to develope them; and, above all, her iron deposits are the most valuable, for not only could we keep £500,000 a year in the colony which is now being sent out of it, but, owing to the vastly superior article got from the titaniferous sand, it is not hoping for too much that at an early date New Zealand will become a powerful competitor with the world in the production of both iron and steel. While giving employment to a large portion of the population, the spending-power of the people would be such as to justify the manufacture locally of many classes of goods that are now imported.

## ART. LXXIII.—*On the Action of Potassium-Cyanide Solution upon Gold.*

By J. S. MACLAURIN, B.Sc.

[*Read before the Auckland Institute, 24th February, 1896.*]

IN the Journal of the Chemical Society (Trans., 1893, pp. 724–738, and Trans., 1895, pp. 199–212) two papers on the action of cyanide upon gold have been published. These papers contain an explanation of the peculiar action of dilute solutions of potassium cyanide, and a record of a number of experiments which, I think, prove conclusively that this explanation is correct and sufficient. So far as I am aware, the statements contained in these papers have passed unchallenged in Europe. In New Zealand, however, Mr. Skey has published* some experiments from which he concluded that no satisfactory explanation had been given of the action of cyanide on gold. As such a statement is likely to mislead those who have not had an opportunity of reading the original papers on the subject, I shall briefly outline my work already referred to, and shall then consider Mr. Skey's views.

The knowledge of the subject when I began my researches was as follows: Gold was known to be soluble in potassium-cyanide solutions, but the nature of the action was disputed. Most of the text-books referred back to Elsner (J. Pr. Chem., 37, 333) and credited him with the explanation embodied in the following equation:—

$$4Au + 8KCN + O_2 + 2OH_2 = 4AuCNKCN + 4KOH.$$

On the other hand, Macarthur (patentee of the cyanide process), in a paper read before the Society of Chemical Industry, (Journal, 1890, p. 270), called in question the necessity of oxygen.

In the extraction of gold from its ores it was known that dilute solutions of potassium cyanide acted more satisfactorily than concentrated ones. Moreover, L. Janin had noticed that silver is more soluble in dilute than in concentrated solutions. No satisfactory explanation was, however, given.

It seemed, therefore, that an answer was required to the following questions:—

1. Is oxygen necessary for the solution of gold in potassium-cyanide solutions?

* Mines Report, 1895, pp. 186–189.

2. If so, does Elsner's equation represent the true amount of oxygen required?

3. What is the relation between the concentration of the solution and the rate of solution of the gold; and what is the explanation of the more rapid action of dilute solutions?

In seeking for an answer to the first of these questions I made several experiments, using both gold foil and gold paper (filter-paper on which metallic gold is precipitated). A gold plate exposed to the action of a 4-per-cent. solution of potassium cyanide, from which air had been removed as far as possible, lost in twenty-four hours only 0·0002 gram., whilst the same gold plate when exposed to the action of this solution with free access of air lost 0·00835 gram. in the same time. A piece of gold paper containing 0·00002 gram. of gold, and having a distinct pink tint, in the absence of oxygen, did not lose its colour for eight days, whilst, when a similar piece was exposed to the action of the same cyanide solution, saturated with air, the colour faded completely in two minutes. These results can leave no doubt as to the absolute necessity of oxygen in order to bring about the solution of gold.

2. Amount of oxygen required for the solution of gold.—I exposed a weighed gold plate to the action of potassium-cyanide solution, enclosed with a measured volume of oxygen in a suitable vessel, and after standing for two or three days I reweighed the plate and measured the volume of the oxygen remaining. I could thus calculate the weight of oxygen required to dissolve a given weight of gold, and I found, as the mean of four experiments, that this weight was within 5 per cent. of that calculated from Elsner's equation. It is therefore evident that Elsner's equation is correct; or, in other words, two atoms of gold require for solution in potassium cyanide one atom of oxygen.

3. What is the relation between the concentration of the cyanide solution and the rate of solution of the gold, and what is the explanation of the more rapid action of dilute solutions?—After numerous experiments, the following plan was adopted to determine this point: Four circular plates of gold, each 22mm. in diameter, were suspended by cotton so as to hang an inch or two from the bottom of a tall glass vessel holding 500cc. of cyanide. By means of a crank attached to a water-wheel, the plates were raised and lowered about an inch twenty times a minute. The solution was kept saturated with air by appropriate means. The plates were exposed to this action for an hour, and were weighed before and after the experiment, the loss in weight representing the gold dissolved. The results are given in the following table:—

TABLE I.

| KCN Grams per 100cc. | Gold dissolved. | KCN Grams per 100cc. | Gold dissolved. | KCN Grams per 100cc. | Gold dissolved. | KCN Grams per 100cc. | Gold dissolved. |
|---|---|---|---|---|---|---|---|
| 50 | 0·00050 | 20 | 0·00277 | 4 | 0·00600 | 0·1 | 0·00675 |
| 45 | 0·00064 | 15 | 0·00350 | 3 | 0·00613 | 0·05 | 0·00666 |
| 40 | 0·00091 | 10 | 0·00440 | 2 | 0·00627 | 0·02 | 0·00613 |
| 35 | 0·00124 | 8 | 0·00488 | 1 | 0·00650 | 0·01 | 0·00345 |
| 30 | 0·00163 | 6 | 0·00537 | 0·5 | 0·00670 | 0·005 | 0·00030 |
| 25 | 0·00210 | 5 | 0·00572 | 0·25 | 0·00684 | | |

These results show that the rate of solution of gold in potassium-cyanide solutions gradually increases as the concentration of the solution decreases, reaches a maximum at 0·25-per-cent. solution, and then decreases continuously. Precisely similar results were obtained with silver. In seeking for an explanation of this remarkable variation in the solubility of gold in potassium-cyanide solutions I was led to investigate the solubility of oxygen in such solutions, and obtained the following results:—

TABLE II.

| Percentage of KCN. | Coefficients of Absorption of Oxygen at 16°C. |
|---|---|
| 50 | 0·0032 |
| 35 | 0·0062 |
| 20 | 0·0123 |
| 10 | 0·0180 |
| Water | 0·0290 |

These results show that the solubility of oxygen in cyanide solutions decreases rapidly as the concentration increases, a 50-per-cent. solution dissolving little more than one-tenth of the amount of oxygen absorbed by pure water. It will be seen from the table already given that the amount of gold dissolved by a 50-per-cent. solution is about one-thirteenth of that dissolved by a solution containing 0·25 per cent. It is therefore evident that the rate of solution of gold in these two solutions is almost proportional to the amount of oxygen contained in each. In Table IV. the relations of the gold to the oxygen are shown under the heading Au/O (found). On considering these it is evident that the solubility of the gold is dependent upon that of oxygen, but that something else interferes with the action. For, if the amount of gold dissolved depended solely on the amount of oxygen in solution, the values for Au/O should be constant; but in the results found

it will be seen that these values differ considerably, gradually decreasing as the concentration increases. Therefore, in more concentrated solutions there is less metal dissolved than the amount of oxygen in solution appears to demand. This points to some retarding action on the motion of the molecules. It seemed probable that viscosity has such a retarding action on the motion of the oxygen molecules in solution, reducing their velocity, and consequently diminishing the number of impacts on the surfaces of the plates in a given time, and so decreasing the amount of gold dissolved. In order to test the validity of this conclusion, the rates of solution of gold were determined in cyanide solutions rendered more viscous by the addition of various substances, such as sugar and glycerol, which might be assumed to exert no chemical influence on the solubility of the metal. The results are shown in Table III.:—

TABLE III.

| — | Grams per 100cc. | KCN Grams per 100cc. | Gold dissolved in One Hour. | Oxygen Coefficients of Absorption. | Au/O. |
|---|---|---|---|---|---|
| Sugar .. .. | 0 | 1 | 0·00650 | 0·028 | 0·232 |
| " .. .. | 5.26 | 1 | 0·00488 | 0·025 | 0·195 |
| " .. .. | 15·78 | 1 | 0·00333 | 0·022 | 0·151 |
| " .. .. | 26·30 | 1 | 0·00243 | 0·021 | 0·116 |
| " .. .. | 36·82 | 1 | 0·00152 | 0·019 | 0·080 |
| " .. .. | 26·30 | 5 | 0·00211 | 0·0187 | 0·113 |
| Glycerol .. .. | 14·15 | 10 | 0·00223 | 0·0171 | 0·130 |
| Gum-acacia .. .. | 1 | 1 | 0·00492 | .. | .. |
| Gelatin .. .. | 1 | 1 | 0·00374 | .. | .. |
| Starch .. .. | 1 | 1 | 0·00443 | .. | .. |

These results prove very conclusively that the assumption in regard to the retarding action of viscosity was correct.

Suppose now that we consider the number of times in a second a given oxygen molecule strikes a surface. We may assume from the results just given that this will depend on the viscosity coefficient $z$, or, in other words, will be a function of $z$. So that, if N be the number, we can write $N = a + bz + cz^2 + \&c.$, where $a$, $b$, and $c$ are independent of $z$ (Maclaurin's theorem); or, since Au/O is dependent upon the number of impacts in unit of time, we can write $Au/O = a + bz + cz^2 + \&c.$ In order to ascertain if these relations hold good for the values of Au and O found, I determined the coefficients of viscosity of a number of cyanide solutions. The observations were made by Gartenmeister's method (Zeit. Physik. Chem., vi., 524), using Finkener's formula—

$$z = \frac{r^4 \pi p}{8lv} - \frac{vs}{8\pi gl}.$$

In this expression $r$ is the radius and $l$ the length of a capillary tube through which a volume $v$ of the liquid of sp. gr. $s$ flows, under a pressure $p$ in unit of time. In the following table the results found by this method are given under $z$. Under Au/O are shown the values found, and also those calculated by the aid of Maclaurin's theorem—that is to say, by the formula Au/O $= a + bz +$ &c., where $a = 0{\cdot}33$ and $b = -0{\cdot}9$. The close agreement of the values found by these two methods is sufficient to prove that the true explanation of the smaller solubility of the gold relatively to the oxygen in the more concentrated solutions is to be found in the greater viscosity of these solutions.

TABLE IV.

| KCN grams per 100cc. | Gold dissolved in One Hour. | Oxygen Coefficients of Absorption. | Au/O. Found. | Au/O. Calculated. | $z$. |
|---|---|---|---|---|---|
| 50 | 0·00050 | 0·0032 | 0·156 | 0·154 | 0·1962 |
| 45 | 0·00064 | 0·0040 | 0·160 | 0·172 | 0·1760 |
| 40 | 0·00091 | 0·0049 | 0·185 | 0·188 | 0·1581 |
| 35 | 0·00124 | 0·00625 | 0·198 | 0·201 | 0·1439 |
| 30 | 0·00163 | 0·0079 | 0·206 | 0·210 | 0·1336 |
| 25 | 0·00210 | 0·0100 | 0·210 | 0·217 | 0·1252 |
| 20 | 0·00277 | 0·0124 | 0·223 | 0·223 | 0 1188 |
| 15 | 0·00350 | 0·0152 | 0·230 | 0·227 | 0·1144 |
| 10 | 0·00440 | 0·0185 | 0·238 | 0·230 | 0·1107 |
| 5 | 0·00572 | 0·0230 | 0·248 | 0·232 | 0·1091 |
| 1 | 0·00650 | 0·0280 | 0·232 | 0·232 | 0·1089 |

Similar experiments are recorded in the papers above referred to with regard to silver, and precisely the same results were obtained with this metal.

The following is a summary of results:—

1. Oxygen is necessary for the solution of gold in potassium cyanide, and no gold is dissolved in its absence.

2. The ratio of the gold dissolved to the oxygen required for its solution is 196 : 8, as demanded by the equation—

$$4Au + 8KCN + O_2 + 2OH_2 = 4AuCNKCN + 4KOH.$$

3. The rate of solution of gold in potassium-cyanide solutions varies with the strength of the solution, being small for concentrated solutions, increasing as the solution becomes more dilute, reaching a maximum at 0·25 per cent. of cyanide, and then again diminishing.

4. The rate of solution of silver in potassium cyanide varies in the same way, and the maximum is reached at the same degree of dilution.

5. The ratio of the amount of gold dissolved by any given cyanide solution to that of the silver dissolved by the same solution is nearly the ratio of their atomic weights.

6. The variation in the rate of solution of gold in cyanide solutions is not directly influenced by the amount of cyanide in solution, except in the case of very dilute solutions, but is mainly due to the solubility of oxygen in these solutions, the amount of gold dissolved being nearly proportional to the absorption coefficients of oxygen in such solutions.

7. The rate of solution of gold is, however, not exactly proportional to the above-mentioned coefficients, but is rather less than it should be for the more concentrated solutions.

8. The explanation of this diminishing ratio of the gold dissolved to the oxygen available, as the concentration of the solution increases, is to be found in the increasing viscosity of the solutions as the quantity of cyanide augments.

9. The explanations given in 6, 7, and 8 are equally applicable to the solution of silver in potassium-cyanide solutions.

Returning to Mr. Skey's paper, to which I have already referred, I give the following extract in order to show the position he takes up. He says, "Why very weak cyanide solutions act as swiftly as they do, while strong solutions do not act upon gold to a degree or at a speed in any way corresponding to what we expect, is a problem that has not, I think, been solved. To account for this it has been assumed that strong solutions of the cyanide do not dissolve oxygen or are not permeated by it as readily as weak solutions are. But that there is a plentiful supply of oxygen in these solutions is made manifest by the results of the following experiments:—

"1. A newly-made cyanide solution of greatest strength is poured into a shallow vessel, and at the bottom of it a small slip of gold leaf gummed on paper is placed. A long slip of the same is then placed so that one end rests upon the bottom of the vessel while the other end projects out of the solution. In a few minutes it may be seen that the whole of the gold on the long slip has been dissolved, while the piece that is wholly immersed in the fluid does not appear to be at all affected.

"2. In the same solution place a slip of gold leaf coupled with platina, so as to lie also at the bottom of the vessel, when in a short time it may be shown that the gold has entirely dissolved, while the gold leaf that was not paired with any negative substance has not been affected. With chalcopyrites for the negative pole the solution of the gold was far more rapid than in the former experiment, when platinum was used for this purpose, showing the advantage there is in pairing the gold with a substance that is strongly electro-negative to it.

"I think the results of these experiments clearly prove

that there is a sufficiency of oxygen present, even in the strongest solutions of potassic cyanide, to allow of the rapid solution of gold therein. But why strong cyanide solutions have so little, or so very slow, an effect upon gold as we find is a question that, in the light of these results, appears as yet quite unanswered. For my part, I am inclined to think that a compound forms upon the gold when in strong cyanide solutions that is either insoluble or but very slowly soluble in these strong solutions, but is soluble to a considerable extent in weak solutions. It is, I think, very probable that the cyanide of gold that first forms on the gold has to be dissolved as a simple cyanide before it can be so acted upon by the potassic cyanide as to pass into the comparatively-soluble aurocyanide of potassium."

It is remarkable that Mr. Skey should make the statement, "It has been assumed that strong solutions of cyanide do not dissolve oxygen, or are not permeated by it as readily as weak solutions are," when he had before him my papers proving that oxygen is less soluble in concentrated than in dilute solutions. In the two experiments that follow this statement Mr. Skey shows that gold when partly immersed in the solution or when coupled with platinum is rapidly dissolved, and concludes "that there is a sufficiency of oxygen present, even in the strongest solutions of potassic cyanide, to allow of the rapid solution of gold therein." It may be as well in the first place to point out that these experiments do not deal with the question of concentration in a satisfactory manner. Whilst it is shown that by partial immersion or contact with platinum the rate of solution of the gold is greatly increased, nothing is given to show the relative effect of solutions of varying concentration in such cases. It is unnecessary, however, to consider this point further at present, as I shall show that in these particular cases the solution of the gold is not due, as Mr. Skoy assumes, to the oxygen in solution, but to electrolytic action.

Perhaps it will be best to consider the question in the successive steps which I took in my investigation.

Fig. 1

Strips of gold leaf (1 to 3, Fig. 1), gummed on paper, were gummed on to the inside of a beaker, into which a saturated solution of potassium cyanide was then poured, until the top of No. 3 strip was just covered. In five minutes No. 2 was almost entirely dissolved, whilst No. 1, which extended partly over the bottom of the beaker, required about thirty minutes. The top of No. 3 was only about ¼in. beneath the surface of the liquid, and yet after standing for an hour there was no alteration in its appearance. Nos. 2

and 2*a* were separated by a space of about $\frac{1}{10}$in., but No. 2*a* showed no change in an hour.

These results prove that for rapid solution a portion of the strip must project above the surface of the liquid; they also suggest the probability of the solution being due to electrical currents maintained by the action, at the surface of the liquid, of cyanide and the oxygen of the air.

In pursuance of this idea the following experiments were made: The strips shown in Fig. 2 (varnished as shown by the shaded portions) were exposed to the solution used in the last experiments. In half an hour that portion of No. 6 below the surface was completely dissolved. In No. 5 the action was the same—all the strip beneath the surface of the liquid, with the exception of the varnished portion, being dissolved. The same was the case with 7, both *a* and *b* dissolving, and apparently at about the same rate. No. 4 showed no alteration. It was suggested above that the solution of the lower portions of the strips was due to electrical action, and this is clearly proved to be the case by the results obtained with Nos. 5 and 7 strips. Let us consider how No. 5 differs from Nos. 2 and 2*a* in the last experiments. So far as chemical action is concerned, one would naturally conclude that 2*a* should be dissolved rather than 5*a*, since the varnished portion separating 5 and 5*a* is very much wider than the space between 2 and 2*a*, and for such action a portion protected by varnish is quite as great a barrier as a blank space. When we consider electrical action, however, the case is quite different: the space between 2 and 2*a* does not allow an electric current to pass, whilst the varnished portion between 5 and 5*a* offers no obstruction to such a current. It is therefore most probable that a current flows, and that the solution of 5*a* is due to its action. Again, in No. 7 the solution of *b* can be explained only by the generation of electric currents in *a*. Hence it follows that the solution of the lower portion of any strip partly immersed in concentrated cyanide of potassium is due to electrical action.

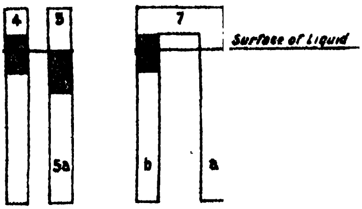

*Fig. 2*

Should any doubt as to the production of an electric current remain, the results obtained in the following experiment must remove it:—

Fig. 3 shows two plates of gold, varnished as shown by the shading. The upper ends of these plates were connected through a Thomson's galvanometer (G in the figure). A rested

on the bottom of a beaker partly filled with a saturated solution of potassium-cyanide, the surface of which stood about half-way up the varnished portion of this plate. As previously shown, with strips of gold paper varnished in a similar manner there will be practically no action on A. When, however, No. 2 plate is lowered into the solution so that B is partly immersed there is strong deflection of the galvanometer, proving that a considerable current is passing; and, from the direction of the deflection, showing that cyanogen is being deposited electrolytically upon A, and that therefore aurous cyanide is formed, which dissolves in the liquid. Hence the gold plate A is dissolved. When No. 2 plate is further lowered, so as to have the surface of the liquid at about the middle of the varnished strip C, the deflection is hardly perceptible; whilst on still further lowering the plate, so as to expose part of D to the action of the solution, the deflection is the same as at first.

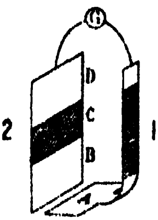

*Fig. 3*

Let us consider the course of the current in the case of a straight strip of gold partly immersed. From the experiments just given it is evident that there must be an electromotive force at the surface of the liquid, and that a current will flow down through the metal and back through the solution to its starting-point. We may consider the portion of the strip beneath the surface of the solution as one pole of a battery, and that portion just at the surface as the other pole. Now, it is well known that when a current passes through an electrolyte (in this case potassium-cyanide solution) the latter is decomposed, its constituents—the ions—appearing at the poles. In the present case cyanogen is liberated at the lower pole, and at once combines with the gold to form aurous cyanide, which unites with potassium cyanide in the solution to form the soluble double salt; whilst the potassium must pass to the upper pole, where it will either decompose water, liberating hydrogen, or unite at the moment of liberation (whilst nascent) with the oxygen at the surface. In either case potash will be formed at the surface.

In order to prove that this is the case, the following experiments were made:—

Three test-tubes (shown in Fig. 4) of the same size were taken. Into No. 1 test-tube 10cc. of a 2-per-cent. solution of potassium cyanide almost free from air were poured. A gold plate was dropped in, and then a thin disc of cork, through the centre of which passed a rod of gold, was placed as shown in the figure. The disc of cork fitted the tube tightly, but a very small strip was cut away at

one side so as to allow all the air to be driven out when the cork was forced into its place. A second 10cc. of the same solution were now added. The gold rod passing through the cork was varnished from a point a little below the surface of the liquid to within $\frac{1}{8}$in. of its lower end, which rested on the gold plate. No. 2 test-tube was filled up in exactly the same way, whilst No. 3 differed only in having neither gold rod nor plate. The three tubes were placed in a small beaker standing in water, and were then covered by inverting over them a beaker, which also dipped into the water, and so protected the solutions from any fumes that might be in the laboratory. After standing for five days the solutions in the upper and lower portions of the tubes were removed separately and analysed in the following manner: 5cc.—*i.e.*, half of the solution—from the top or bottom of each test-tube was titrated with $AgNO_3 \frac{N}{50}$. This gave the amount of free potassium cyanide remaining in the solution; the other half was evaporated to dryness with the addition of a few drops of sulphuric acid, and the residue was heated first alone and then with small additions of ammonium carbonate. This residue, which consisted of potassium sulphate and metallic gold, was weighed, and the gold determined by the usual assay process. The amount of potassium sulphate obtained from 5cc. of solution, both above and below the cork, was thus known. From the gold found the amount of potassium cyanide in the double cyanide of gold and potassium can be calculated; the amount of free potassium cyanide is also known. The sum of these two values, calculated as sulphates and subtracted from the total amount of potassium sulphate found, gives the amount of potassium sulphate existing in the solution as potash. Now, if the solution of the plate be due to oxygen in the solution below the cork, potash will be formed there; therefore, in such a case, the ratio of the potash found below the cork to that found above it will be the ratio of the gold dissolved in these two places. If, however, the solution of the plate be due to an electric current generated at the surface of the solution, no potash will be formed below the cork, but only at the surface of the solution. Of course, there is sure to be some oxygen below the cork, and this will act upon the plate independently of the electrical action, and so form a small amount of potash in the lower portion of the tube. However, to prove that a current flows, and in the direction stated above, it is only

*Fig. 4*

necessary to show that the ratio of the potash formed above the cork to that formed below it is greater than the ratio of the gold dissolved above to that dissolved below. The following results show that this is the case :—

| | | | | (1.) Gram. | (2.) Gram. |
|---|---|---|---|---|---|
| KHO | from 5cc., | top of test-tube | | 0·0155 | 0·0171 |
| „ | „ | bottom | „ | 0·0075 | 0·0088 |
| Gold | „ | top | „ | 0·0333 | 0·03195 |
| „ | „ | bottom | „ | 0·02674 | 0·0232 |

| | | (1.) | (2.) |
|---|---|---|---|
| $\frac{\text{KHO above cork}}{\text{KHO below cork}}$ | = | $\frac{0·0155}{0·0075}$ | $\frac{0·0171}{0·0088}$ |
| | | 2·06 | 1·94 |
| $\frac{\text{Gold above cork}}{\text{Gold below cork}}$ | | $\frac{0·0333}{0·02674}$ | $\frac{0·03195}{0·0232}$ |
| | | 1·24 | 1·37 |

The titration of the solutions in No. 3 test-tube showed that, although the decomposition in the top solution was rather greater than that in the solution below the cork, the difference was so slight as not to affect the above results.

These experiments clearly show that the solution of a gold plate partially exposed to the air is largely due to electric currents acting in the manner above described.

In regard to Mr. Skey's second experiment, in which he coupled gold lying at the bottom of a cyanide solution with platinum, I have repeated it several times, but have failed to get his results. This may be due to the fact that he does not enter into detail sufficiently to insure any one repeating the experiment under exactly the same conditions. The following are some of my experiments in regard to this matter :—

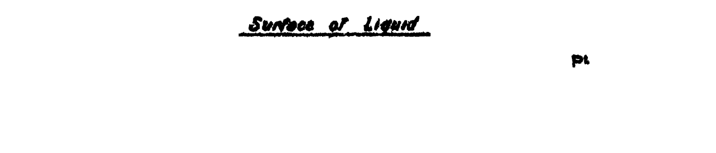


Fig. 5

In Fig. 5, 1 and 2 are small strips of gold foil (gummed on paper) lying at the bottom of a saturated solution of potassium cyanide. 3 and 4 are like the last, and in addition they have lying across them narrow strips of platinum attached with gum to one edge of the gold. 5 and 6 differ from 3 and

4 only in having a platinum wire in 5, and a strip of platinum in 6, resting as shown in the figure, and projecting above the surface of the liquid. In half an hour 1, 2, 3, and 4 were apparently unaltered, whilst 5 and 6 were almost completely dissolved. After twenty-four hours 1, 2, 3, and 4 showed no appreciable alteration. I now suspended a platinum wire so that one end rested on No. 1 strip, the other projecting above the surface of the liquid. In the same way a platinum strip (varnished at the surface of the liquid) was suspended so as to touch No. 2 strip. In forty minutes No. 1 was almost entirely dissolved, whilst No. 2 showed no alteration.

These results are very similar to those obtained with gold strips partly immersed, and show clearly that, as in the former case, solution of the gold is due to an electric current generated at the surface of the liquid.

The following experiments were made in order to determine what influence oxygen in solution has on the electrical solution of gold. Two circular plates of gold of the same diameter were marked 1 and 2 respectively; a narrow slit was cut in each near the margin, and the plates weighed. Through one of these slits one end of a long strip of gold about ¼in. wide was passed and bent back on itself, being tapped with a small hammer to insure close contact with the plate; the other end of the strip of gold was bent round a glass rod, resting across the top of a Nessler glass containing 50cc. of cyanide solution. By this means the plate was suspended in the cyanide solution at about ½in. from the bottom of the vessel. The gold strip was varnished from within ¼in. of the plate to within ¼in. of the surface of the liquid. The second plate was suspended by cotton at the same depth in the second Nessler glass, which also contained 50cc. of the same cyanide solution. In other words, the conditions were the same for the two plates, except that one was suspended by gold and the other by cotton. After being exposed to the action of the cyanide solutions for one hour the plates were removed and reweighed. The strip of gold was now attached to No. 2 plate, No. 1 being suspended by cotton, and the experiment repeated, still keeping No. 2 plate in No. 2 Nessler glass. These four determinations were made first in a solution containing little air, and then in the same solution saturated with air. The results are shown in the following table, the means only being given. The weights shown are in terms of assay weights: 1,000 = 0·5 gram:—

| KCN per Cent. | Gold Plate suspended by | With Little Air in Solution. | Solution saturated with Air. | Increase due to Air. |
|---|---|---|---|---|
| 25 .. .. | Gold strip .. | 0·70 | 1·00 | 0·30 |
| | Cotton .. | 0·45 | 0·90 | 0·45 |
| 10 .. .. | Gold strip .. | 2·30 | 3·10 | 0·80 |
| | Cotton .. | 1·05 | 2·20 | 1·15 |
| 1 .. .. | Gold strip .. | 2·65 | 4·50 | 1·85 |
| | Cotton .. | 1·50 | 3·25 | 1·75 |
| Totals.. | Gold strip .. | 5·65 | 8·60 | 2·95 |
| | Cotton .. | 3·00 | 6·35 | 3 35 |

If we consider the totals in the above table it will be seen that in the case of the plates suspended by cotton saturation of the solution with air increases the amount of gold dissolved by 3·35, whilst in the case of the plates suspended by gold the increase is only 2·95. In the former case, solution takes place in the manner already explained in my earlier papers on this subject; in the latter, in addition to this mode of solution there is solution due to electrical action. Now, if these actions be independent of each other, the results found for the plates suspended by gold must represent the sum of these actions (chemical and electrical). Suppose this to be the case: then, in the above table, the amounts (totals) dissolved by electrical action will be 2·65 and 2·25—*i.e.*, 5·65 − 3 and 8·6 − 6·35. It appears from this that an increased amount of oxygen in solution decreases the electrical action, whilst it very materially increases the chemical action. Of course, the determinations made are not numerous enough to insure absolutely correct results, but they are quite sufficient to show that the electrical action is independent of the oxygen in solution. Therefore, Mr. Skey's conclusion, that because gold partially immersed in saturated cyanide solutions rapidly dissolved there must be a considerable amount of dissolved oxygen, is incorrect.

After stating this conclusion, Mr. Skey proceeds—"But why strong cyanide solutions have so little or so very slow an effect upon gold as we find is a question that in the light of these results appears as yet quite unanswered. For my part, I am inclined to think that a compound forms upon the gold when in strong cyanide solutions that is either insoluble or very slowly soluble in these strong solutions, but is soluble to a considerable extent in weak solutions. It is, I think, very probable that the cyanide of gold that first forms on the gold has to be dissolved as a simple cyanide before it can be so acted upon by the potassic cyanide as to pass into the comparatively-soluble aurocyanide of potassium."

As my experiments have fully answered the points raised by Mr. Skey, it is hardly necessary to consider the above hypothesis except to point out that there is nothing to base it upon. I have already shown that in potassium-cyanide solutions the rate of solution of gold is due to the same causes as that of silver. Now, it is well known that silver cyanide is more rapidly soluble in concentrated than in dilute solutions of potassium cyanide, and why Mr. Skey should assume that the reverse is the case with the gold compound is inexplicable.

In conclusion, I wish to point out that nothing has been adduced by Mr. Skey to weaken the theories stated by me in regard to the solution of gold in potassium-cyanide solutions. These theories were advanced to explain the action of pure potassium-cyanide solutions on pure gold wholly immersed therein, and of course were never intended to include the cases of partial immersion, or those of contact with other substances, both of which require special consideration of the kind described in the latter part of this paper.

## Art. LXXIV.—*Notes on Mr. J. S. Maclaurin's Paper on the Action of Potassium-Cyanide Solutions upon Gold.*

By William Skey, Government Analyst.

[*Read before the Wellington Philosophical Society, 26th February, 1896.*]

This paper is a reply to a part of a communication of mine that appeared in the Annual Report of the Mines Department for 1895, and, in justice both to Mr. Maclaurin and to myself, I make these few notes thereon.

In regard to the publications of his that he cites showing the great insolubility of oxygen in strong or concentrated solutions of potassium cyanide, all I wish to say is that at the time I wrote my contribution for the Mines Department my acquaintance with the facts that he has given and his theory respecting these was entirely gathered from short notices of his paper as scattered in other works, and I regret my knowledge of his labours in this matter being then so slight as it was. However, Mr. Maclaurin will find that in a part of my annual Laboratory Report that was in page form on the 8th February,* and is now just about ready for issue, I had acknowledged both the accuracy and the great value of his discovery that potassic-cyanide solutions are absorptive of oxygen to a degree that is approximately the inverse of their strengths; and as I (in common with most chemists) have always held that free oxygen is required for the cyanide pro-

* This fact is certified to by a letter I have from the Government Printer.

cess, I allowed in that communication of mine that Mr. Maclaurin had solved the question in its practical bearings as to why gold is so slightly affected by strong cyanide solutions as experience has proved it to be; and, further, I proved that even in those cases where an electric current is produced during the solution of gold in potassic cyanide, free oxygen is also necessary.

One of the points upon which Mr. Maclaurin does not agree with me is where I state that a product is generated on the gold in the cyanide solution that hinders the dissolution of this metal to a more or less extent. In answer to this I would refer him to page 45 of the Laboratory Report cited, where, as an additional result supporting this, I prove that by the amalgamation test the cyanodizing or oxidizing of the gold is always much ahead of its dissolution. As to the author's statement that it is inexplicable why I should assume that the gold compound that first forms is insoluble in strong potassic cyanide, while the analogous silver compound is more rapidly dissolved therein than in the weak solution, I would answer that I have not tied myself to any particular gold compound—nor yet to any one—the formulæ of which is known, and my result certainly appears to show that at least there is a gold compound that forms in potassic cyanide which is very slowly soluble therein.

As to the inability of Mr. Maclaurin to confirm my statement regarding the results of electrically pairing platina with gold, except I allow that the platina must project out of the cyanide solution, I have to say that if the platina is wholly submerged therein, it all depends upon the area of the two metals relatively to each other as to whether the result I describe is easily observed or not. If the area of the platina considerably exceeds that of the gold—as was the case in my experiment—so much free oxygen present in the solution is available for oxidation that the dissolution of the gold is sufficiently accelerated to allow of its being easily observed. If the platina is allowed to project above the cyanide, it does, as Mr. Maclaurin observes, take the place of gold, and the dissolution of that metal is still further accelerated. There is another difference in our mode of conducting the experiment the knowledge of which helps to reconcile our differences on this point: I worked with shallow depths of liquid; the author had his metals deeply submerged; and, as I rely somewhat on the absorption of aërial oxygen going on simultaneously with the dissolution of the gold, the result I stated did not come out so well by the use of Mr. Maclaurin's method.*

* These remarks have an application to the metallic sulphides.

And now in regard to the theory the author of that paper advances to explain the singular fact that I published as to the rapid dissolution of gold in concentrated solutions of the cyanide when the gold plate used is but *partly* submerged. This theory is that the dissolution of the submerged gold in these cases is due to electrolytic action produced at the surface of the cyanide next to the atmosphere; and in support of this statement he shows, and by incontrovertible evidence, that electric currents are produced under these circumstances.

Now, I am very glad to have all this evidence from Mr. Maclaurin, as it goes to sustain a statement of mine to the same effect, and which was in page form in the Government Printing Office for the Laboratory Report cited, page 44,* on the 8th of February, consequently before I saw his paper. There I stated, in effect, that an electric current is produced when gold is partly submerged in potassic cyanide. On this point, then, we agree; but when I go over his statements in regard to the *direction* of this current, and its relations to, or its bearings upon, the dissolution of gold, I am quite unable to agree with him, nor can I agree with him in regard to his statement that potassium is set free in any of his experiments. These three points I will take consecutively.

First, then, as to the direction of the current—that is, as to the particular part of the apparatus where this electromotive power is generated: Mr. Maclaurin states that it is generated at the *surface* of the liquid, and that the current will flow down to the submerged end of the gold. But I state, in the report referred to, that it is the *lower* part of the submerged gold where this electromotive power is generated—that is, in my own words, "the lower end being the positive pole"; and I show that the electromotive power generated by the lower end (the more deeply submerged end of the gold strip) is sufficiently strong to electro-deposit copper from its sulphate. I have now also tested the direction of the current in the apparatus figured 3 in Mr. Maclaurin's paper, and, as I expected, find that the lower end of the submerged gold strip certainly is the positive pole in this apparatus too.

Second, as to the relation of the electric current, or this electrolytic action, as it is termed, to the dissolution of gold in the potassic cyanide. Mr. Maclaurin assumes that it is this current—this action—which causes the solution of the gold in the cyanide. Now, I must contend here that it is just *vice versâ*; that, in fact, Mr. Maclaurin has got the cart before the horse—the effect for the cause. I contend that the current (or the electromotive power) is produced by chemical action alone—that is, by the dissolution of the lower sub-

* The Government Printer also certifies to this by letter.

merged end of our gold strip. To be explicit: so far from the submerged gold requiring an electromotive power to pass it into solution, it *produces* electromotive power as it dissolves, and of sufficient intensity, as I show, to electro-deposit copper from its sulphate or gold from its cyanide. To go to particulars: taking Mr. Maclaurin's own conception as to the chemical operation that goes on in the process, viz., that the cyanogen of the cyanide attacks the submerged gold direct, while the potassium combines with oxygen at the other end of the metal (a happy conception fitting the case, and apparently true), I should maintain that the cyanodizing of the gold and the oxidizing of the potassium are the initiatory steps in the process, and the current observed is the effect of this and not the cause as assumed. The function of the interpolar connection (gold, platina, or conducting sulphide, as the case may be) is to conduct the electricity generated, and so to allow a long slip of the liquid itself to be polarized; the effect of which is that cyanodizing and oxidizing can and do go on simultaneously in the localities especially suited for each process.

Now, I have stated in the notes of mine referred to that the rapid chemical action that occurs at the gold near to or above the surface-line of the cyanide solution had a "misleading effect upon me"; and I think that Mr. Maclaurin will soon have to confess to a similar experience on his part. The gold is so rapidly dissolved at that place that the electric current observed is at first naturally assumed to have been generated there; but, though there must be electricity generated there, it does not become electromotive power, being merely that of local action of the kind we have when we use common zinc for a pole, and it takes no part in the dissolution of the submerged gold. Any way, the dissolution of this submerged end can be rapidly effected without it—that is (to keep exactly to the text), without the assistance of any electromotive action taking place at the surface, or, indeed, anywhere else. This is proved by the results of the following experiment taken from my old working-notes:—

In the following figure (Fig. 1), representing the apparatus that I used, the vessel A contains a saturated aqueous solution of potassic cyanide. B contains a weak solution of common salt. C contains an aqueous solution of potash. D, D are glass tubes filled with sodic chloride solution to make interpolar connections. E, F are strips of gold leaf glued to paper (for support), and connecting with each other through the galvanometer G. The cyanide solution is covered with a layer of oil.

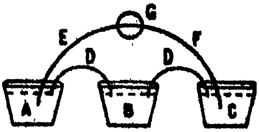


Fig. 1

So soon as the electric connection is made through the galvanometer G, a current of electricity is produced, the direction of which shows that the gold in the vessel A (cyanide solution) is the positive pole of the voltaic pair, and in a short time the gold in that vessel will have dissolved away from its support, while that in the vessel C is not at all affected.

Now, here there can be no electromotive action at the upper surfaces of any of the liquids; and there is no electrical effect produced except that which goes to form the electromotive power that is given out at the surface of the gold that is in the cyanide solution A. Clearly, then, the gold in this case is not dissolved by electrolytic action, and consequently in Mr. Maclaurin's experiment (see his Fig. 3*) the gold A at the bottom was not dissolved by electrolytic action as he contends. In my experiment, for the potash in vessel C may be substituted any of the acids, even nitric acid, with the same results. With the metal silver the results are of the same kind—that is, the silver is rapidly dissolved by the cyanide, and this even when the silver in the nitric acid is being rapidly dissolved, thus showing the great affinity of silver for cyanogen.

These results certainly appear to prove that Mr. Maclaurin has been all along upon this particular matter mistaking, as I have said, the effect for the cause.

In case these results may not be deemed sufficient proof of the incorrectness of this theory of the author's, I give the details of another experiment, with its results.

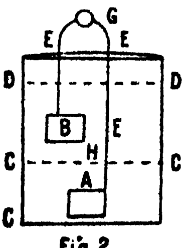

Fig. 2

A and B are slips of gold leaf in electrical connection with the galvanometer G by insulated wires E, E. A is in a concentrated solution of potassic cyanide C, C, C, C, while the gold B is in a weak cyanide solution, or in potash solution C, C, D, D, partly separated from the strong cyanide by a diaphragm H. By this apparatus a strong electric current is generated, and the gold plate A is shown to be positive to the plate B, and very soon dissolves in the liquid.

Here we get entirely rid of all chemical action at the surface of a liquid (D) in contact with the atmosphere, consequently of all electrolytic action that could possibly be produced there; and yet the dissolution of the gold in a concentrated solution of the cyanide goes on as rapidly as it did in Mr. Maclaurin's experiments.

Now, just setting aside galvanometric indications altogether, Mr. Maclaurin may contend here that, by allowing, as I

* Above, p. 708.

have, that there is oxidation going on at the surface of the gold in vessel C, Fig. 1 (oxidation of potassium), simultaneously with the cyanodizing of the gold in vessel A, I have weakened the strength of my argument that the gold A in the strong cyanide is the positive element of the voltaic pair which is produced in this apparatus. In such a case I would answer him by stating that the free oxygen at this pole (the gold F) simply takes the place of the combined oxygen of the potash next to it, pushing that atom of oxygen on to another atom of potash to the displacement of its particular atom of oxygen, and so on till the chlorine is reached, when this radical is pushed on in like manner till cyanogen is reached, which in its turn is slid on, as it were, till the last atom of it in the line of action collides with the gold, and a chemical effect then and there takes place that is productive of the electromotive power that we find. The gold at that point thus shows itself to be the positive element of the apparatus, which is in strict accordance with the law that it is always the metal that is attacked which determines the direction of the current. But I maintain that during these actions never is any atom or fraction of an atom of either oxygen or cyanogen at any time absolutely freed from all combinations; it is, as it were, a waltz in which the dancers are ever changing partners, but not one of them is ever clear of a partner—that is, never in a state of isolation.

In regard to this matter, I would state here that lead in strong soda solutions, like gold in strong "cyanide" solutions, is oxidized and dissolved far quicker when only partly immersed than when wholly immersed therein. Like gold in cyanide solutions, lead is also more soluble in weak potash solutions than in its strong solutions. Lead in a strong potash solution is weakly positive to lead in a weak potash solution, but becomes more positive when the other piece of lead is placed in nitric acid, and so becomes rapidly dissolved. In these cases I also suppose the aërial oxygen takes the place of the oxygen of the potash next to it, and the sliding process goes on till the lead is reached, when strong chemical action takes place.

That the positive pole should be that at which the least chemical action takes place seems inexplicable until we consider that the direction of the current is here determined by intensity, not by quantity; and the current that is produced by the lead in the potash solution is more intense than that produced by the lead in the nitric-acid solution, because (in part at least) free oxygen of the air is the exciting agent in that case, while in the case of the acid solution a combination has to be broken up for the oxidation of the lead, which, of course, involves a lessening of electric intensity of the current

thus produced.* Besides that, this free oxygen is greatly condensed as it replaces the combined oxygen of the potash.

I note here that the vice-president of the Institution of Mining and Metallurgy at the Geological Museum, Jermyn Street, London, in a paper on "selection action" in the cyanide process,† and which generously deals with much old work of mine, takes the same view as Mr. Maclaurin does of electrical action as being the cause and not the effect of chemical action in the process of Macarthur and Co. So Mr. Maclaurin is in very good company. The paper itself, as may be seen, has been in a large measure anticipated by the two publications of mine referred to, in the parts dealing with the selective action of the patentees of the cyanide process.

Thirdly, in regard to the assumption that potassium is liberated from potassic cyanide in the experiment figured 3 in his paper, I would observe that Mr. Maclaurin omits to give me any proof of this, and that therefore it is impossible for me to think otherwise than that this assumption is altogether an unreasonable one. It is true, however, that Professor Gladstone, Ph.D., F.R.S., and Mr. Alfred Tribe, in a paper read before the Royal Society in 1875,‡ gave the sanction of their names to this idea of a liberation of potassium under circumstances somewhat similar to those we have in Mr. Maclaurin's experiment, but, as these investigators have not replied to the strictures I made thereon, I suppose they have abandoned that idea. However it is, I would, in answer to Mr. Maclaurin's assumption, refer him to these strictures of mine,§ and supplement them by the following remarks:—

As Mr. Maclaurin well knows, the affinities of this metal (potassium) for oxygen are of extraordinary intensity; for cyanogen also they are very intense, as a white heat alone does not decompose either compound. To this I think Mr. Maclaurin will agree; and, if so, how can he assume that the feeble electric current that he supposes to be produced at the surface of the liquid can overturn affinities like

* More investigations are required in this direction before the reason of this can be thoroughly understood. This action of metals in strong and weak solutions of alkalies is anomalous. Iron in strong HCl coupled with itself in the weak acids did not give me a current, the intensity of the electricity generated in each cell being alike. Copper in sulphuric acid is positive to copper in nitric acid.

† "On the So-called Selective Action of Very Dilute Solutions of Cyanide of Potassium used in obtaining Gold and Silver from Ores and Compounds," by James Mactear. Read before that institution, November, 1895, and first seen by me 17th March, 1896.

‡ "On the Replacement of Electro-positive by Electro-negative Metals in a Voltaic Cell." Proc. Roy. Soc., Lond., 1875.

§ "Notes on the alleged 'Replacement of Electro-positive by Electro-negative Metals in a Voltaic Cell,'" by William Skey. Trans. N.Z. Inst., vol. viii., 1875, pp. 343–345.

these to give us the potassium in a free state? But supposing even that he had an electric battery laid on of sufficient power theoretically to liberate potassium from its cyanide, how can he expect even then to have potassium set free for the minutest portion of time when there is water, also free oxygen, in contact with the potassium compound during the whole time that chemical action is going on? No; I consider that in the experiments of all these investigators the potassic cyanide or the potassic chloride is simply passed to the oxide by a substitution so direct that never was any of the metal set free. A person travelling over the boundary of two Shires has never any part of his person clear of both; so here the atom of potassium in exchanging companions is never clear—that is, never free in any part of it of one or the other. This is the position I have long taken on the subject generally, and I cannot retire from it before I have something more than mere assertions, whatever direction they come from.

I would like to make here a few observations in connection with Mr. Maclaurin's important discovery of the great insolubility of oxygen in strong solutions of potassic cyanide. In the Laboratory Notes of mine already referred to I state, in affirmation No. 2, "That, generally, any salt added to a good working solution of the cyanide acts the same as an equal quantity of the cyanide in retarding or preventing dissolution of gold."* Now, these facts lead me to suppose that it is a general law that all aqueous solutions of salts, fixed alkalies, and alkaline earths are also solvent of oxygen in a proportion inversely to that of their strength; that, in fact, Mr. Maclaurin's law for the cyanide solution is really a general law for all saline solutions. This receives some support from the fact that a great number of solid salts, when dissolved in ordinary water at a common temperature, liberate gas, while if the water has been boiled for a considerable time, then rapidly cooled, and then immediately placed over any of these salts, not a trace of gas can be seen to escape therefrom as the salt dissolves. I formerly considered that the gas escaping when crystallized salts were placed in water was simply the air they had occluded in the act of crystallization; but it appears pretty clear to me now that this was one of my misconceptions.

In the light that our recent discoveries throw on the exact chemical nature and reactions involved in the cyanide process, I now venture to state here my opinion on the question as to whether in that process as conducted at the mines the gold is first oxidized or cyanodized; and it is this: In a plentiful

* The fixed alkalies act similarly, but not ammonia or chloride of ammonium.

supply of free oxygen a part of the gold is directly oxidized, while another part, and that the larger part, is cyanodized, while, if free oxygen is scarce, the less gold is oxidized and the more is cyanodized, until in those extreme cases where free oxygen is entirely absent, while at the same time the gold is in contact with minerals conductive of electricity, or is but only partly submerged in the cyanide, all the gold is then won by being directly cyanodized.

In conclusion, I again express my regret that at the time I prepared my notes on the cyanide process for the Mines Department I was unacquainted with Mr. Maclaurin's communication to the Chemical Society on this subject. I had no chance to ignore it, as I am supposed to have done; and if I had had that chance Mr. Maclaurin may be sure that it would have been the furthest from my thought to take it. Not to say anything about the dictates of common honesty, which may or may not rule my dealings with the world, my own native caution and hereditary prudence would have told me that a paper prepared so skilfully, so laboriously, and with such a wealth of illustration and of argument as this was, is not one to be "ignored" by anybody except to his own disadvantage and dishonour. On the other hand, I would assure Mr. Maclaurin that I am very much pleased to learn that one of our university colleges has turned out of its roomy and well-fitted halls a native-born New-Zealander who has entered the wide and fascinating field of original research among the physical sciences, and made his *début* among our brother scientists of the Old World in the strikingly successful and honourable manner that he has. And I shall be glad to see his example followed by other New-Zealanders, and also to have the valuable assistance continued of a friendly but full criticism of any other communications to the scientific world that I may have the opportunity of laying before it.

NEW ZEALAND INSTITUTE

# NEW ZEALAND INSTITUTE.

## Twenty-seventh Annual Report.

Meetings of the Board were held on the following dates: 18th January and 31st May, 1895.

The members elected, in conformity with the Act, by the incorporated societies as Governors of the Institute are: Mr. James McKerrow, Mr. S. Percy Smith, and Major-General Schaw.

The retiring members from the Board—viz., Mr. W. T. L. Travers, Mr. W. M. Maskell, and the Hon. W. B. D. Mantell—have all been reappointed by His Excellency the Governor.

The Board regrets to have to record the death of Professor Huxley, thereby creating a vacancy in the list of honorary members of the Institute.

The members now on the roll of the Institute are: Honorary members, 29; ordinary members,—Auckland Institute, 171; Wellington Philosophical Society, 150; Hawke's Bay Philosophical Institute, 82; Philosophical Institute of Canterbury, 65; Otago Institute, 102; Nelson Philosophical Society, 22; Westland Institute, 62: making a total of 683.

The volumes of Transactions now in stock are: Vol. I. (second edition), 245; Vol. V., 18; Vol. VI., 20; Vol. VII., 105; Vol. IX., 108; Vol. X., 140; Vol. XI., 30; Vol. XII., 38; Vol. XIII., 35; Vol. XIV., 60; Vol. XV., 170; Vol. XVI., 170; Vol. XVII., 172; Vol. XVIII., 145; Vol. XIX., 160; Vol. XX., 161; Vol. XXI., 93; Vol. XXII., 93; Vol. XXIII., 170; Vol. XXIV., 175; Vol. XXV., 175; Vol. XXVI., 180; Vol. XXVII., not yet fully distributed.

The volume (XXVII.) just published was issued in June, and contains seventy-two articles, and also addresses and abstracts which appear in the Proceedings. The work contains 742 pages of letterpress and 42 plates. The following is a comparison of the contents of the present with those of last year's volume:—

| | 1895. Pages. | 1894. Pages. |
|---|---|---|
| Miscellaneous ... ... ... | 154 | 202 |
| Zoology ... ... ... | 298 | 258 |
| Botany ... ... ... | 154 | 88 |
| Geology ... ... ... | 30 | 76 |
| Proceedings ... ... ... | 58 | 64 |
| Appendix ... ... ... | 48 | 42 |
| | 742 | 730 |

The cost of printing Vol. XXVI. was £447 19s. 6d. for 730 pages, and that for the volume just issued (XXVII.) £441 16s. for 742 pages.

During the past year the manuscript of the library catalogue has been completed, and is now being printed, but it will not probably be ready for issue for some months.

An arrangement has been made with Mr. A. Hamilton for the production of a standard work on Maori art, illustrated by photographs of carvings and other articles, which now are becoming very rare, and a permanent record of which should be preserved. Mr. Hamilton has travelled in the interior of the North Island for this purpose, and has already accumulated a large and interesting collection of photographs, from which selections will be made. It is hoped to have the first volume, containing 100 plates, ready for issue by the end of the year.

The Honorary Treasurer's statement of accounts shows that there is a balance in hand in the current account of £58 6s. 8d.

The amount appropriated for the publication of memoirs and postponed papers (according to resolution) is now £758 7s.

Approved by Board. JAMES HECTOR,
GLASGOW, Manager.
Chairman.

6th August, 1895.

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NEW ZEALAND INSTITUTE ACCOUNTS FOR 1894–95.

| *Receipts.* | £ | s. | d. | *Expenditure.* | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Balance in hand, 19th July, 1894 .. .. | 96 | 12 | 6 | Printing Vol. XXVII. | 441 | 16 | 0 |
| Parliamentary grant for 1894–95 .. .. | 490 | 0 | 0 | Expense of library, cataloguing, &c. .. | 39 | 16 | 0 |
| Sale of volumes .. | 1 | 18 | 6 | Foreign postage, freight on books, stationery, and miscellaneous .. | 38 | 14 | 0 |
| Contribution from Wellington Philosophical Society .. .. | 18 | 14 | 6 | Publication of work on Maori art .. .. | 87 | 12 | 10 |
| | | | | Balance .. .. | 58 | 6 | 8 |
| | £616 | | | | £616 | 5 | 6 |

WM. THOS. LOCKE TRAVERS,
12th August, 1895. Honorary Treasurer.

# PROCEEDINGS

# WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting : *3rd July, 1895.*

Mr. T. Kirk, F.L.S., President, in the chair.

The President expressed his thanks for the honour conferred upon him by his election to the chair for the current year. He made a brief reference to the recent death of Professor Huxley, to whose distinguished abilities he paid a graceful tribute. Mr. Kirk then read his inaugural address, "The Displacement of Species." (*Transactions*, p. 1.)

Sir James Hector proposed a vote of thanks to the President for his interesting address. He agreed with the view that the vast changes which had been effected in the fauna and flora could never be recovered from. Some were good and others very bad, and often resulted from the misdirected energy of colonists who did not realise how easy it is to disturb the delicate balance of nature.

Mr. Travers had great pleasure in seconding the vote of thanks. He had often pointed out the necessity of taking steps to prevent the introduction of undesirable plants, &c. Foreign organisms obtain a greater flourishing power here than in their own climate. He had observed the rapid growth in New Zealand of plants that would be considered insignificant in their own country—and the same with insects. Nothing was done to prevent the spread of injurious plants and insects in the first instance, and it is difficult to do it now. Snakes and toads are not allowed into the country, although they are really useful; but stoats and weasels are introduced, and they are doing harm all over the country, and it is penal to destroy them.

The vote of thanks was carried.

Mr. Kirk returned thanks.

*New Members.*—Dr. A. G. Talbot, Mr. A. Haylock.

Second Meeting : *17th July, 1895.*

Mr. T. Kirk, F.L.S., President, in the chair.

*Papers.*—1. "On Rare Lepidoptera in the Wellington District," by W. P. Cohen. Specimens exhibited. (*Transactions*, p. 377.)

The President said there was much interesting information in Mr. Cohen's paper, and complimented him for making such a valuable collection.

Sir James Hector thanked Mr. Cohen for his offer to leave the specimens in the Museum for a few weeks on exhibition.

2. "On the Discovery of a New River and Valley in the Vicinity of Milford Sound," by D. Sutherland; communicated by Sir J. Hector. (Plate XXXVII.)

ABSTRACT.

In 1884 Mr. Sutherland made some interesting geographical discoveries on the sea-coast south of Milford Sound (see vol. xvi., p. 454). He now announces a further discovery, and forwards a sketch-plan. The entrance to the valley is at the north end of Transit Beach. A river, the existence of which was not before suspected, was followed up for five miles, winding about in a flat valley about one mile wide. The stream is tidal for about two miles, and its banks at that point are 12ft. high, and composed of fine mud containing cockle-shells. The source of the river was discovered to be a waterfall issuing from a mountain-tarn, which was named Lake Ursula. The surrounding mountains are very precipitous, and formed of naked rock, in which quartz reefs and mineral lodes were seen, the latter giving indications of garnets, copper- and iron-pyrites, hæmatite, and magnetite. Sir James Hector described the country where the discovery was made. The river had not been marked on the maps of that part of the West Coast.

3. "On Dusky Sound," by R. Henry; communicated by Sir J. Hector. (*Transactions*, p. 50.)

Sir James Hector pointed out that there was ample room for explorations in this district, especially for those engaged in the study of natural history.

The President agreed that this district was still a splendid field for the botanical collector.

4. Mr. Archibald Park, M.R.C.V.S., of Tasmania, by invitation, read a paper, and exhibited specimens, on "Animal and Vegetable Parasites associated with the Production of Neoplasms in Cattle and Sheep." (*Transactions*, p. 451.)

Sir James Hector said that Mr. Park was acknowledged to be a great authority on these matters. It had given him great pleasure to visit Mr. Park's splendidly-appointed laboratory in Tasmania, and he took this opportunity of thanking him for having come forward so kindly for the purpose of laying the results of his researches before the meeting.

Mr. Maskell also complimented Mr. Park on the valuable work he had done.

Several questions were asked by members and answered by Mr. Park.

Professor Dendy, of Canterbury College, Christchurch, pointed out the important bearing of biological study from an economical point of view.

The President having thanked Mr. Park for his interesting paper, invited members to view the objects, prepared by that gentleman, under the microscopes.

## THIRD MEETING: *31st July, 1895.*

### Mr. T. Kirk, F.L.S., President, in the chair.

The President: Before entering on the formal business of the meeting I wish to draw your attention to a subject in connection with which the various societies affiliated with the New Zealand Institute appear to have been slightly remiss, if I may venture to say so. A recent mail brought news of the death of Dr. David Lyall, R.N., at Cheltenham, in his seventy-eighth year. Many present will be familiar with his name as the medical officer in charge of the botanical collections on board the "Terror," one of the ships of the British Antarctic Expedition, 1839–43. I have no intention of giving a full account of his work, as that is being done by Sir Joseph Hooker, with whom he was so closely associated in botanical explorations on the Auckland and Campbell Islands, the Bay of Islands, Falkland Islands, Magellan Straits, Kerguelen Land, &c.; but I may remind you that when, in 1847, Admiral Stokes commissioned the "Acheron" for survey work on the west coast of the South Island, Dr. Lyall was appointed medical officer, and for three years lost no opportunity of engaging in botanical exploration in the South Island and in Stewart Island; and it was not until Sir James Hector's adventurous exploration of the western portion of Otago that any additions were made to the mass of information collected by Dr. Lyall with regard to the phytology of that district. Full testimony to the value of Dr. Lyall's work is borne by Sir Joseph Hooker throughout the "Handbook of the New Zealand Flora." To my mind, the additions made by him to the cryptogamic flora of Dusky Bay show his keen power of observation to great advantage, following as he did such excellent collectors as Forster, attached to Cook's second expedition, and Menzies, who accompanied Vancouver's expedition. It must also be remembered that he had high merit as a naturalist. The first account of the kakapo that reached Europe was contained in a paper prepared by him, which was read before the Zoological Society in 1852, and attracted great attention. Now, the point I wish to make is this: that, after having rendered such great service in the elaboration of the New Zealand flora, his name has not been placed on the roll of honorary members of the New Zealand Institute. Unquestionably this is simply an oversight, but one much to be regretted. We have been remiss alike in the discharge of duty and in the exercise of privilege; and I venture to suggest that, when the members are next called upon to nominate individuals for honorary membership, those who have rendered direct service to the scientific workers of the colony in past years should have preference over those whose claims, however worthy, are of a more general character. As one of the oldest members, and for some years a governor of the Institute, I confess myself blameworthy in not having drawn attention to this point at an earlier date.

Sir James Hector quite agreed with what Mr. Kirk said regarding the late Dr. Lyall, who was an old personal friend, with whom he had explored in Vancouver Island thirty-five years ago, and he felt sure that had his name been submitted he would have been elected an honorary member. It was a most unfortunate oversight, for no one could have been more worthy the honour than the late Dr. Lyall.

*Papers.*—1. "On Antarctic Research," by Major-General Schaw, C.B., R.E. (*Transactions*, p. 62.)

Sir James Hector thanked General Schaw for having undertaken and so well performed the duty of making an abstract of these important papers. He hoped that the efforts of the promoters of antarctic research would be more successful this time than previously. It was a blot on

our enterprise that so large an area of the earth's surface should still remain unknown. The little we did know was most interesting, and had a direct bearing on many scientific problems. For instance, it will be impossible ever to thoroughly understand and forecast weather changes throughout the world until we are acquainted with the meteorology of the south polar region, as all the great secular changes appear to originate there. It is often said that our southern seasons follow those of the Northern Hemisphere, and this year has at first sight afforded a marked instance; but the true explanation is that, owing to the North presenting such a large condensing surface, with extensive arid areas over which the sky is clear, as compared with the immense water-area with clouded sky in the South, changes that are affecting the whole globe are more rapidly developed in the Northern Hemisphere. Again, life, especially the marine mammalia, is known to be abundant in southern latitudes, and, from the enormous migrations of penguins and seals that leave the temperate localities where they breed every year in a very poor and lean condition, but return from high latitudes loaded with fat, fish and other marine food must exist in great profusion. When we know that the distance of the great south land from New Zealand is the same as to Sydney, and that no attempts have been made to reach it since steamers equipped for combating the ice have come into use, we may feel certain that an expedition would encounter no serious difficulty. He therefore cordially supported the proposal.

Mr. Hudson said such an expedition would be most useful in settling questions regarding the distribution of plants and animals, and afford increased knowledge for those engaged in the study of biology.

Mr. Tregear, although he recognised the immense scientific results to be obtained by a south polar expedition, said the practical point was that the colony was to be asked for a grant-in-aid. This would be the difficulty.

Mr. McLeod asked if the expedition would be officered from the Royal navy, or in part from the colonies contributing.

Mr. E. F. Hadfield remarked that the bearing, as pointed out by General Schaw, of the variations of the constant of gravity upon the determination of the earth's centre of gravity was very striking. Pendulum experiments in the antarctic circle, if they showed how far the centre of gravity of the earth lay from the centre of form, and in what direction, would throw much light on the nature and amount of the motion of the earth's axis. He recalled the fact that Newton, after making laborious calculations and observations with a view of showing that the moon's motion was due to a force the same as that attracting bodies at the earth's surface, but diminished in intensity according to the law of the inverse square, found that the observed facts did not harmonise with the results of calculation; that, after a more accurate measurement of an arc of the meridian, the new data thus supplied, on being introduced into the calculation, produced the harmony sought for, and established the law of gravitation with all its intricate consequences. The way in which Newton put aside a pet theory when inconsistent with fact, instead of trying to make facts fit the theory, was an admirable instance of the honesty of the true scientist. The determination of the distance and direction of the earth's centre of gravity from its centre of form would affect, more or less, almost all astronomical observations, and might perhaps alter accepted notions of precession, nutation, and even aberration, and might have further far-reaching consequences in astronomy. This would be the more interesting in view of the light astronomy was throwing on the sister science of geology, and the inferences being drawn from both as to the time and mode of the origin of the globe. If this were realised, the practical difficulty of getting public support for an antarctic expedition might vanish. Observations of the

transit of Venus obtained support because one main object of them was to determine with greater accuracy the sun's distance from the earth, and this was easily recognised as a basic fact in astronomy. Moreover, when a new fact of widespread significance to science was discovered it was difficult to be sure that practical benefit might not rapidly ensue.

The President said that such an expedition would be of the very greatest importance and benefit. There are many questions of great interest awaiting the results of such an expedition. He mentioned the great abundance of cetacean life that would be met with: surely there must be some opening for commerce in this direction.

General Schaw, in reply, said, no doubt those in command of such an expedition would be selected from the older countries, and not from the colonies. Unfortunately, the whales met with in these parts were not the most valuable whales. He considered that the motion of the ice was caused by currents and not by winds—there were strong polar currents. A slight shifting of the pole would have a great effect.

## 2. "The Ultimate Problem of Philosophy," by W. W. Carlile, M.A. (*Transactions*, p. 74.)

Sir James Hector complimented the author for his interesting paper. It was difficult to discuss a subject of this kind without having carefully read the paper. There were one or two things in the paper that he could not agree with; but time would not permit of their being gone into. He supposed it was Mr. Carlile's parting shot at evolution (as Mr. Carlile is leaving the colony shortly).

Mr. Tregear said that he considered the reading and discussion of such papers perfectly futile, and that they would in no way disturb the position of the evolutionists.

Mr. Harding thought the paper a good one, and he agreed generally with Mr. Carlile; but there was nothing very new brought forward in this paper.

Mr. Hudson thought Mr. Carlile's allusions as to the origin of the sense of beauty in animals was a strong point in his paper. Although fully believing in Darwin's theory of sexual selection, he thought that that theory implied a sense of beauty in female animals that it was difficult to account for.

General Schaw said the line of argument adopted by the lecturer was somewhat difficult to follow, and required time for consideration; but he could well believe that it might convince some minds which were dissatisfied with the argument from design. The latter line of argument was, he thought, more generally useful, and, although for a time discredited, it was now reasserting itself strongly, and had been used most powerfully by Sir George Stokes in some of his recent lectures.

The President said that, although he might not agree with Mr. Carlile on many points, yet he considered the paper most lucid, and very interesting.

Mr. Carlile, in reply, said, with reference to Sir James Hector's description of his paper as "a parting shot at evolution," he must draw attention to the fact that he had treated evolution as an established doctrine. What he thought was altogether fallacious was what was called agnosticism—the notion that the world could be regarded as a watch, but without any maker. He felt sure that in twenty years' time it would be thought incredible that any one should ever have entertained such a conception of the universe.

## 3. "On *Cordiceps robertsii*," by H. C. Field. (*Transactions*, p. 623.)

### Fourth Meeting: *21st August, 1895.*

Mr. T. Kirk, F.L.S., President, in the chair.

*Papers.*—1. "On the Unusual Abundance of Certain Species of Plume-moths during 1894–95" (with specimens), by G. V. Hudson, F.G.S. (*Transactions*, p. 379.)

Sir James Hector would like to know about what time of the year these moths occur, and are they injurious to plants? Is it the caterpillar of this moth that perforates the leaves of the *Piper excelsum?*

Sir W. Buller said that the *Piper excelsum* is attacked in private gardens as well as in the bush, the plants in his garden having their leaves completely riddled.

The President thought that the abundance or absence of these insects was owing to the scarcity of the plants they feed on, and also to temperature; but no definite conclusion has yet been arrived at on the subject.

Mr. Hudson, in reply, said that he was not yet sufficiently acquainted with the life-history of these moths to say positively if they injured plants. He knew they fed on *Piper excelsum*, but did not think they injured the plant. They occurred from November to February. Perhaps it was the absence of their special enemies that caused these moths to be so abundant during the seasons mentioned.

2. "Notes on New Zealand Ornithology in the Marlborough District," by Walling Handley; communicated by Sir Walter Buller. (*Transactions*, p. 360.)

The President said that a record of this kind was very valuable. Unfortunately, some of our native birds were fast disappearing from many districts where they were once numerous. He was glad to hear that the pigeon was still plentiful in Marlborough, as there were very few localities in which it was to be found in any quantity.

3. "Further Notes on the Ornithology of New Zealand," with an exhibition of specimens, by Sir Walter Buller, K.C.M.G., F.R.S. (*Transactions*, p. 326.)

4. "On the Occurrence of the Nankeen Kestrel of Australia (*Cerchneis cenchroides*) in New Zealand," by Sir Walter Buller, K.C.M.G., F.R.S. (*Transactions*, p. 359.)

Mr. Travers said his son had examined Stephen Island, and had come to the conclusion that there were not more than about a dozen of the small wrens on the island. He would not have sent all those he obtained—seven in number—to England had he at first known they were so scarce. He believed that now the birds were absolutely extinct on the island. The whitehead he understood was common on the wooded hills at the back of Paraparaumu. The various islands should be visited, and collections made for our museums; and he agreed that steps should be taken to protect our birds. The rail at the Chatham Islands is fast being destroyed. He considered that the naturalists themselves do a great deal of mischief in getting rid of the rare birds.

Mr. Hudson thought that science was much indebted to Sir W. Buller for the extremely interesting and able paper just read. In 1893 he himself had written a short paper pointing out the immediate necessity for making extensive collections of New Zealand plants and animals, so many species of which would no doubt shortly become extinct.

Mr. Harding said that we should certainly endeavour to protect our rare species of birds. He would suggest that the Maoris be asked to supply notes of the life-history of those creatures that are soon likely to pass away. A native chief lately described how native birds are captured, and gave very good drawings, and the Maoris were well able to supply valuable information about the native birds. He might mention, in passing, that Mr. Colenso was quite recently searching for some mineral specimens at his house in Napier and came on a box of botanical specimens collected fifty years ago, and until now quite forgotten. Among them are three native ferns never met with since by himself or other observers. No doubt we shall hear about them soon from Mr. Colenso.

The President said he heartily indorsed Sir Walter Buller's protest against the trinomial nomenclature which was now becoming fashionable amongst zoologists. He considered it to be useless for any good purpose, while it must inevitably cause confusion. He was glad to think that it was not likely to be adopted in New Zealand.

Sir W. Buller, in reply, said he was glad to find that one occupying the position of our President, and actively engaged in scientific work, was so strong an advocate of the binomial system of nomenclature. As to Mr. Travers's remarks about the supposed extinction of the island-wren, he thought that the cat that had done so much for science, in having brought in uninjured all the known specimens of this interesting bird, verily deserved an apotheosis; although, in his opinion, it would have been better to have kept cats out of the island altogether. It was satisfactory, however, to learn that Mr. H. Travers's seven specimens had all been secured by Mr. W. Rothschild, because he would make good use of them in the interest of science, and because the Tring Museum was already famous for its New Zealand rarities. For all that, he still urged the permanent importance of compiling a type-collection of rare birds for the Colonial Museum before their final extinction had rendered it impossible. Of almost equal importance with this was the completion of their history; and he quite agreed with Mr. Harding that it would be well to encourage intelligent Maoris to record their observations. He had seen the paper by Tamati Ranapiri on the ancient modes of snaring wild birds, which had been contributed to the Polynesian Society. It was most interesting from every point of view; and the pen-and ink sketches by the writer with which it was illustrated were very creditable productions. So-called savages were known to be good observers of nature, and it would be quite a step in the right direction to invite contributions of this kind for our Transactions.

The President exhibited specimens of the true edelweiss (*Leontopodium alpinum*, Cass.), from the Alps; also of the so-called New Zealand edelweiss (*Helichrysum leontopodium*, Hook. f.), from Hikurangi, East Cape district; and *Helichrysum grandiceps*, Hook. f., from Mount Rolleston, in the South Island. He stated that the former was the *Gnaphalium colensoi*, Hook. f., of the "Handbook of the New Zealand Flora," and drew attention to the fact that *Helichrysum pauciflorum*—a new species described in the last volume of the Transactions—differed from *H. grandiceps* only in the absence of the large woolly bracts and in certain minor characters.

## Fifth Meeting: *4th September, 1895.*

Mr. T. Kirk, President, in the chair.

*Papers.*—1. "On the Construction of the Comb of the Hive-bee," by Coleman Phillips. (*Transactions*, p. 479.)

The author asserted not only that Darwin and all the followers of Darwin who have dealt with the same subject have wholly failed to account for the origin and growth of the habits and powers exercised by the hive-bee in its various operations, and more especially in the construction of the honeycomb, but also that the laws propounded by Darwin and his followers as regulating the evolution of habits and instincts are entirely insufficient to produce the observed results. And he further contended, in support of his assertion, that the exercise by this insect of its observed habits and powers must be referred to its possessing what are understood as reasoning faculties, derived by it, in common with all other forms of life, from what he terms "some force, energy, or intelligence in nature" or "common vital force."

Mr. Tregear did not see any reason for suggesting any force other than those already recognised by science. The power of natural selection to differentiate and to reject unstable combinations was sufficient to account for the advantages possessed by certain animals. There was no attempt made by Darwin to combat the argument from design or the idea of a Creator. It was a far more magnificent idea to think that some jelly-fish or ascidian was constructed to hold the germ of the future man than that a distinct act of creation brought into being every oak, every bird, every human being. There is no reason for requiring any influence beside that of the power which produces and reproduces, along the same lines through endless generations, all the different living beings which form the animal and vegetable kingdoms.

General Schaw said that he had in his first presidential address argued against the commonly-received view that Darwin's theory of natural selection was a fact, not an hypothesis, and that the extreme theories of evolution founded on that theory were all to be taken as established truths. It appeared to him that the quotation he had read from Mr. Darwin's book was open to serious criticism. He could not see that circles were used by the bees in any way in the construction of their cells, nor could he see the slightest evidence that natural selection had anything to do with the intelligence, or instinct, or guidance of the bees in their hive-work. He could not admit that any proof of evolution by natural selection had ever been obtained, not even by the late Professor Huxley in his supposed pedigree of the horse; yet he believed that Darwin, with his wonderfully patient and diligent collection of facts, and his great sagacity, had discovered a part of one of the laws by which variations had occurred in the directions intended. But that the law of natural selection accounted for the endless varieties and perfections of living things in the past and the present was to him absolutely incredible and entirely without proof. Possibly in the future we might attain a further insight into the hidden workings of the Creator, but at present they were surrounded with mystery, and we must confess our ignorance.

Mr. Harding said that it was not well that any scientific theory should have so overshadowing an influence as to be regarded as outside criticism. It was in the theoretical portion of the paper just read that the writer was not strong. That insects and other creatures had senses unknown to man—perceptions of physical conditions revealed to us only by scientific instruments—seemed very probable, but that they possessed mechanical or mathematical knowledge in the ordinary sense was very doubtful. It might be of advantage to consider an ant-hill or bee-hive as a single organism, the individual being merged in the society.

Any living organism under the microscope presented the appearance of a community. The analogy was very strong. In the vital fluids of plants or animals might be seen a host of cells engaged in constructing leaf, flower, and seed, or bone, nerve, or muscle, and others busily removing effete tissue—all working towards a common end, in orderly fashion, with exactly the same appearance of intelligence and individual volition as was seen in an insect community, and, like them, engaged on problems which involved profound mathematical relations. Even in the inorganic world, in the phenomena of crystallization, for example, the same mathematical relations came into play, and the beautiful fronds of ferns and forms of marine creatures were simulated by the frost on a window. If we attributed intelligent action to the visible agents in one case, we should be almost compelled to admit it in all. He had no theory to bring forward—the subject had been so exhaustively discussed by men of the highest powers that it was scarcely possible to adduce anything new.

Mr. Maskell did not agree with either side, but if anything he rather went with Mr. Phillips. He was opposed to the Darwin theory. He did not think Mr. Phillips intended to show that the bee had an inherent knowledge, but that there was intelligence behind the bee. He objected to the theory of Darwin being termed an hypothesis; it was really a doctrine to those who believed in it, and according to them must be right, and those who do not think with them are sneered at, not only on the question of creation but on deeper grounds. He did not agree with Mr. Phillips, as he failed to give us any idea as to what he meant by the "higher intelligence" or the "vital force." Mr. Phillips was setting up a little Darwinian theory of his own. He stated that the dragon-fly's eye is not equal to the human eye: it is doubtful if any insect can see more than 3in. or 4in.

The President said that it was altogether unjust to impute the unfair and illiteral utterances of certain evolutionists to the author of the theory. Darwin was scrupulously careful to state the evidence for and against his own views with equal fairness, and in this afforded a bright example to investigators of all classes. He never shrunk from the conclusions to which his inquiries led him, but he was invariably careful to show respect for the opinions of those who differed from him. In this respect many of his so-called followers had come short of the example he had set.

Mr. Phillips, in reply, thanked members for their courteous criticism, but he thought their remarks tended towards a recognition of the principle he contended for—viz., vital force or intelligence. In reply to Mr. Tregear, he (Mr. Phillips) thought that, while natural selection played a minor part, the real work was effected by a common vital energy, force, or intelligence. He himself had often marvelled at the individual movement of minute bodies evidently endowed with a vital energy of which we know nothing. Mr. Phillips could not tell Mr. Maskell what the vital force was until he had produced his examples step by step, when the meaning would be quite apparent to all.

General Schaw asked permission to make a few observations on the subject of antarctic research, which he had the honour of bringing before them in a paper read at one of their late meetings. And first with regard to the right whale, on which there had been some discussion. He had seen lately a paper read by Mr. Clements Markham before the Royal United Institute in London on "Antarctic Research." From that paper and the discussion upon it it seemed probable that a paying whale-fishery might be found in antarctic waters. It is certain that right whales carrying the valuable whalebone—which is the support of the remarkable nets or fringes by which these whales collect their minute food—are caught in New Zealand waters. He was informed that such

whales frequent a narrow channel on the north-east coast of the North Island, where they are caught in strong nets. The habitats and breeding-waters of these whales are within the antarctic zone. Captain Rose mentions having seen them, and last year the well-known whale-fisher Captain Larsen reported that he had harpooned one in those waters but lost it. The antarctic right whale was not so valuable as the arctic whale, the whalebone being shorter, yet it had a very high price in the London market. He was glad to be able to state that, contrary to the fears expressed by Mr. Tregear at the former meeting, the subject of antarctic research was being favourably considered by the Premier, and there was a good prospect that the Australasian Colonies would unite in voting a moderate contribution to the expense of an undertaking in which they are so greatly interested. There could then be no doubt that the Mother-country would at once organize an exploring expedition to these unknown regions. From such an expedition we might confidently expect to obtain most important results, both of practical and scientific value.

The President stated that the right whale had been taken in these waters within the last seven years. There was a most interesting paper on this subject in the volume of our Transactions for 1886.

Mr. McKay said it was the first time he had heard of a right whale being in these seas. He thought there must be a mistake in the matter, and the whale meant was no doubt the large sulphur-bottom whale, a specimen of which could be seen in the Museum. The whalebone was not of much value.

The President stated, in reply to Mr. McKay, that no one had asserted that the Greenland whale was to be found in the Antarctic Ocean, but the term "right whale" had come to be applied, perhaps loosely, to any large whale yielding the remarkable substance known as whalebone. Instances of its use were frequently to be seen in the newspapers of the day. He directed the attention of the members to a most interesting paper on antarctic exploration by the late Charles Traill, published in the 19th volume of our Transactions,* in which frequent mention was made of the "southern right whale," or "black whale," as it is called by the whalers.

[Note.—The following whalebone whales are recorded for the southern seas: (1) *Neobalæna marginata* (the pigmy whale); (2) *Eubalæna australis* (the black whale); *Megaptera lalandi* (the humpback whale); *Physalus australis* (the southern great rorqual); *Balænoptera huttoni* (the pike whale). No. 1 is the nearest representative of the right whale, or bowhead, of the Arctic seas. The black whale (No. 2) is the *tohora* of the Maoris, and is the one usually pursued by southern whalers. Its whalebone is only one-fifth of the value of that of the right whale.—Ed.]

## Sixth Meeting: *25th September, 1895.*

### Mr. T. Kirk, President, in the chair.

*Papers.*—1. "Notes on *Dactylanthus taylori*," by T. Kirk, F.L.S. (*Transactions*, p. 493.)

Sir W. Buller said there was a drawing of this plant in Mr. Taylor's book.

Mr. Tregear pointed out that the Maori name of this plant is hardly correct.

2. "On a Cranial Fallacy," by E. Tregear, F.R.G.S.

3. "Notes on MS. Descriptions of Collections made during

* Trans. N.Z. Inst., xix. (1886), 479.

Captain Cook's First Voyage," by T. Kirk, F.L.S. (*Transactions*, p. 491.)

Mr. Harding said he had brought up this question of obtaining the MS. in question before the Council of the Wellington Philosophical Society, and it had been referred to the Governors of the New Zealand Institute, who took steps to procure it, together with the valuable plates. He was glad that the MS. had arrived.

Mr. Maskell also said that he was pleased that the application from the Governors of the New Zealand Institute had been successful. They had taken action immediately it was brought to their notice.

## SEVENTH MEETING: *16th October, 1895.*

Mr. T. Kirk, President, in the chair.

It was announced that Major-General Schaw had been nominated to vote in the election of Governors of the New Zealand Institute for the ensuing year, and that Mr. W. Mitten, F.L.S., was nominated as an honorary member of the Institute.

*Papers.*—1. "On a New Species of *Deinacrida*, or Forest-cricket, from Nelson," by Sir W. Buller. (*Transactions*, p. 323.)

Mr. Travers said he thought it was the larva and not the complete insect that bored the holes in trees. He showed some fine specimens of another kind from an island near D'Urville Island. They were found among the stones on the beach.

Mr. Hudson said this was a most interesting paper. This group of insects was peculiar to New Zealand. It is difficult to say how long they take to become perfect. Some other species also drill holes in wood.

Mr. Kirk said it would be interesting if it could be ascertained how long it took the insect to reach full growth. In the Kaipara district these insects live on the palm. He had never heard before that the weta was poisonous.

Mr. Hustwick said that in Nelson it was supposed to be poisonous.

Sir W. Buller, in reply, stated that, in addition to its small size, the larva was light-coloured. It subsisted chiefly on wood, and probably enlarged its home as it increased in size. He always found the large species (*Deinacrida heteracantha*) on branches of trees, where, according to the Maoris, it subsisted on green leaves. He believed this latter species had been extinct on the mainland for twenty-five years or more, but it was still occasionally to be met with on some of the islands in the Hauraki Gulf. The specimen exhibited measured, with appendages, not less than 12in. in extent. The two fine specimens, male and female, shown by Mr. Travers belonged to the species *Deinacrida rugosa*, Buller (vol. iii. of the Transactions). Till now the type-specimen in Mr. P. Buller's collection was unique. It was interesting to learn that it lived among the rocks. The type came from Nelson, from Mr. Brough, the discoverer of the new species described this evening. As to the alleged venomous nature of the weta's bite, he could not speak from his own observation, but he had experienced a stinging sensation on being pricked by one of the spurs of the hind legs. He had once suffered severely from the bite of the spider *Latrodectus katipo*, and this had taught him caution in such matters. It would be interesting to test the potency of the

weta's bite, if some enthusiastic votary of science would submit to the infliction, and he commended the subject to the consideration of members.

## 2. "On Seasonal Time-adjustment in Countries South of Lat. 30°," by G. V. Hudson, F.E.S.

Abstract.

The author proposed to alter the time of the clock at the equinoxes so as to bring the working-hours of the day within the period of daylight, and, by utilising the early morning, so reduce the excessive use of artificial light which at present prevails.

Mr. Travers said the clocks could be managed by having different hands. He did not think we were far enough advanced to adopt the plan advocated by the author of the paper.

Mr. Harding said that the only practical part of Mr. Hudson's paper had long since been anticipated by Benjamin Franklin, one of whose essays denounced the extravagance of making up for lost daylight by artificial light. Mr. Hudson's original suggestions were wholly unscientific and impracticable. If he really had found many to support his views, they should unite and agitate for a reform.

Mr. Maskell said that the mere calling the hours different would not make any difference in the time. It was out of the question to think of altering a system that had been in use for thousands of years, and found by experience to be the best. The paper was not practical.

Mr. Hawthorne did not see any difficulty in carrying out the views advocated so ably by Mr. Hudson.

Mr. Hustwick was of opinion that the reform spoken of would have to wait a little longer.

Mr. Richardson said that it would be a good thing if the plan could be applied to the young people.

Mr. Hudson, in reply, said that he was sorry to see the paper treated rather with ridicule. He intended it to be practical. It was approved of by those much in the open air. There would be no difficulty in altering the clocks.

## 3. Mr. Harding read a short paper entitled "An Ornithological Note." (*Transactions*, p. 376.)

Mr. Travers said it was like the statement that the kiwi laid one egg which took two years to hatch. He presumed that Mr. Harding wished to caution people against such unreliable books.

Sir W. Buller said that such blunders ought to be corrected. He had occasion to take a similar course with blunders of leading writers when dealing with New Zealand natural history, such as confounding the kakapo, a nocturnal parrot subsisting entirely on mosses and other vegetation, with the kea, or sheep-killing parrot, from the mountains. It would be a mistake not to correct such statements. It was not surprising to find mistakes of this kind in the class of books referred to, the product of paste-pot and scissors, and got up for a foreign market.

The President said that it was to such blunders as those pointed out by Mr. Harding that many erroneous views regarding our natural history may be traced. He mentioned several instances.

## 4. "Further Notes on *Dactylanthus taylori*," with specimens and drawings of the flowers, by T. Kirk, F.L.S. (*Transactions*, p. 496.)

Sir W. Buller said it was a curious thing that this plant was so sporadic in its distribution. With the exception of the locality mentioned by Mr. Hill, it appeared to exist in single plants distantly scattered over the country. It was first discovered by the Rev. R. Taylor. In his

"New Zealand and its Inhabitants" there is a good figure of the flower. This is one of the most interesting things in his book. Mr. Taylor made mistakes in the ornithology of the country, but he was most observant and devoted to natural history. It was satisfactory to learn from the President that this plant had been met with in the Rangitikei district, and he hoped it would yet turn up in his own bush in the Manawatu.

Mr. Maskell said, if it were likely to be found in the South he would get some friend to be on the look-out for it.

The President said that the plant occurred at the Thames, East Cape, New Plymouth, Upper Whanganui, and Rangitikei, but was most plentiful at East Cape. He could not speak positively about the South.

Sir W. Buller exhibited the following:—

1. An albino tui (*Prosthemadera novæ-sealandiæ*). This was the first instance he had met with of a perfectly white tui. It was a young male, from Stewart Island. Entire plumage milk-white, with tinge of cream on shoulders, back, and sides; even the bill and feet are white.

2. Specimen of tree lizard described by Mr. Colenso as *Naultinus versicolor* (Trans. N.Z. Inst., vol. xvii., p. 150), so called on account of its having the faculty of changing its colour under the influence of certain emotions. It was obtained by Mr. A. Luff at Vogeltown, and he presented it to the Museum in that gentleman's name. Mr. Luff remarks that this lizard in its colour resembled the bark of the manuka-tree upon which he captured it, about 5ft. from the ground.

The President exhibited specimens of the fruit of the makomako (*Aristotelia racemosa*), which he thought would become an article of export from this colony. It was found of great use in colouring wines, and would probably prove superior to the Chilian species, which was largely imported into France for that purpose.

The President submitted for inspection a number of coloured drawings of New Zealand Veronicas which he had received from Sir Joseph Hooker, who had prepared them for publication in Curtis's *Botanical Magazine*. Most of them had been made from cultivated plants, and differed slightly in appearance from wild specimens, owing probably to the difference in soil and climate; but there was no structural difference of the slightest importance. The series was specially interesting, as it comprised several forms which had not been named or described.

## EIGHTH MEETING: *13th November, 1895.*

Mr. T. Kirk, President, in the chair.

*New Members.*—Mr. A. McDougall, Mr. H. D. Bell, and Mr. T. Hislop.

The President informed the meeting that steps were being taken to found a national memorial to the late Right Honourable T. H. Huxley, and that those wishing to subscribe to the fund for the memorial could do so by communicating with Professor Parker, of Dunedin, who was acting as general secretary in New Zealand.

The President also stated that news had just been received of the death of Professor C. V. Riley, the head of the Agricultural Department

at Washington. He spoke most highly of the services rendered to all countries by the late professor, and of his readiness to impart any information to those who asked for it. He believed Mr. Maskell had a resolution to propose on the subject.

Mr. Maskell, in proposing the resolution, gave a short account of the valuable work done by Professor Riley generally, and particularly referred to the services he had rendered to this colony. Professor Riley was an honorary member of the New Zealand Institute, and therefore, he might say, a member of this Society. He felt sure that all would regret the loss of so able a man.

*Resolution.*—1. That the Wellington Philosophical Society records its very high appreciation of the services rendered by the late Professor C. V. Riley to commerce and industry in all countries by his labours in economic entomology, and its deep regret at the great loss which the world has sustained by his sudden death. 2. That the President be requested to ask the Consul for the United States in New Zealand to forward the foregoing resolution to the family of the late Professor Riley, and also to the Agricultural Department at Washington.

This was seconded by Mr. Travers, who spoke very highly of the late Professor Riley, and carried.

*Paper.*—"Note on the Geology of the Outlying Islands of New Zealand," by Sir James Hector. A large collection of specimens and photographs, with maps, &c., were exhibited to illustrate the paper.

Abstract.

The lecturer gave the results of observations made during a visit to the islands, as a guest of His Excellency Lord Glasgow, from the 29th January to the 25th February, 1895. The distance steamed in the "Hinemoa" was 2,600 miles, and, with the exception of the visit to the Macquaries and the landing at the Bounty Islands, the programme was fairly well accomplished, notwithstanding that unusually boisterous weather was encountered for the season of the year. The lecturer's researches on the botanical features, bird life, and general topography of the islands having been already fully described,* only those parts relating to the geology of the islands need be recorded.

1. *The Snares.*—These islands form two groups about five miles apart. They, on all sides, present precipitous cliffs to the sea, rising from 75 to 90 fathoms depth of water, without shingle or sandy beaches, there being only a few indentations of the coast-line where landing from a boat is possible. Only at one of these, the Boat Harbour, was the nature of the rock-formation actually observed. It is a very singular form of red granite (?), the only rock in New Zealand to which it bears resemblance being the red granite at the entrance to Chalky Inlet; but it differs in being less compactly crystalline, the quartz being granular, and the mica, though in large crystals, being in small proportions. The rock-masses decompose freely, having large naked domes on the surface, between which are profound hollows filled up to the level with peaty matter and bird-guano to a great depth, as proved by the excavations made for a lighthouse-site some years ago. The cliffs rise 300ft. to 500ft. vertical from the sea, and are especially bold on the west coast, where they display a stratified and columnar structure, which suggests a doubt as to the granite nature of the island as a whole.

2. *Auckland Island* is clearly connected with the Snares by a ridge or plateau, the soundings ranging from 66 to 196 fathoms only. So

* Chapman, F., "Transactions of the New Zealand Institute," vol. xxiii., p. 491; and Kirk, T., F.L.S., in the Report of the Australasian Association for the Advancement of Science, vol. iii., p. 213.

far as seen, Auckland Island is altogether volcanic, and closely resembles the rock-structure of Banks Peninsula. The northern part recalls the aspect of the country north of Waikouaiti, with conical hills formed by denuded basaltic sheets; but further south along the east coast there is a succession of harbours or inlets like those in Banks Peninsula, the steep shores of which are formed of successive sheets of basaltic lava, often columnar, and varying from 10ft. to 80ft. in thickness. These are separated by brightly-coloured layers of volcanic tufa or ashes containing interspersed blocks of all sizes. The lava-flows can be traced by the eye to the highest peaks overlooking the west coast of the island, all dipping eastward at from 5° to 10°, but at the north and south ends of the island the slope is towards these directions. Along the west coast there are no indentations, only precipitous cliffs, and one off-lying rock, "Disappointment Island," which is probably a "neck" or "dyke" through which some of the igneous rocks have been extruded. Carnley Harbour divides Adam's Island from the mainland, and appears to have been formed by a dislocating east-and-west fault. The south side of Adam's Island is the most exposed part of the Aucklands, and presents cliffs composed, as exposed in section, of horizontal layers of basalt and tufa to a height of 1,900ft., some of the cliffs being 1,400ft. sheer down. The lava-sheets vary in thickness from 10ft. to 80ft., and there is evidence of not less than seventy disinct outpourings still preserved above the sea-level. A sounding three miles off shore from the South Cape gave 95 fathoms (575ft.). The average dip of the lava-floes to the eastward is 7°; the width of the island in this section is ten miles, and the height of the western cliffs 1,000ft.; so that, by adopting the usually-accepted curve for volcanic deposits, we have the following result: Auckland Island is the remnant of a great volcanic cone that was 12,000ft. in height and fifty miles in diameter in early Tertiary times, the chief centre having been about eight miles west of Disappointment Island. Four-fifths of the original mass has been removed by the denuding force of the westerly waves.

3. *Campbell Island* is a volcanic mass, but has the peculiar feature of having slightly above the sea-level the original rock-formation on which it is founded. On the north and south it presents fantastic peaks and precipices, carved out of rocks of the same character as those which form Otago Peninsula. Towards the southern end it is traversed by Perseverance Harbour east and west, which is by a moderately high saddle connected with West Harbour. On the north and south of this rift are frowning cliffs and peaks of basaltic lava-sheets; but at the sea-level there is an exposure, both on the east and west coasts of the island, of the Upper Cretaceous rocks, with chalk flints and fossil wood, such as is found in New Zealand in the Upper Amuri series. These have been brought to the surface-level together with the volcanic outburst, as they are injected and interstratified with dykes and tufa-rocks of the same kind. The wonderful mystery of the occurrence of fossilised dicotyledonous wood in the far south latitude of Campbell Island is therefore thrown entirely out of the distribution of plant-life in Tertiary times, and must be referred to the Cretaceous epoch. At an altitude of 800ft. clear evidence of the former existence of a true corrie and moraine of the first order was obtained, but it is purely local, and is the only evidence of former glacier action observed.

4. *Antipodes Island* is the result of four distinct centres pouring out scoria and basaltic lavas with enormous deposits of volcanic breccia, which proves the great local violence of the eruptions. The erosion of the coast-line has been very slight considering the friable nature of the rock, so that the eruptions must have occurred in a very late geological time, coincident probably with those of the Auckland Peninsula.

5. *Chatham Islands* have a very complex structure, the northern

part being composed of the oldest metamorphic rocks that occur in New Zealand, and the southern part and Pitt's Island of Lower Tertiary and Cretaceous rocks. The soundings between the Chathams and Banks Peninsula did not exceed 800 fathoms.

The results of the voyage indicate so far that New Zealand is the remnant of a mountain-chain that formed the crest of a great continental area that stretched far to the south and east, and which is now submerged to a depth not much more than 2,000ft.

The President felt sure that all were delighted with Sir James Hector's most interesting lecture. It was rather late to take the discussion on it, and it was proposed and carried that the discussion be postponed to that evening fortnight.

The President drew attention to specimens of double-flowered columbines, exhibited by Mr. H. Phillips, Tinakori Road. In some of these flowers the tubular recurved petals had completely disappeared and been replaced by flat, lanceolate, shortly-stalked petals, clearly resembling the ordinary sepals, but arranged in several series, the innermost being reduced to merely expanded filaments. The change to a regular symmetrical flower was very striking, especially in those where the petals were arranged in not more than two series. This transformation of filaments into petals was usually attended by an increase in the number of carpels from five to eight or nine. In other specimens the spurred tubular petals were largely increased in numbers.

NINTH MEETING: *27th November, 1895.*

Mr. T. Kirk, F.L.S., President, in the chair.

It was announced that the following gentlemen had been elected Governors of the New Zealand Institute to represent the incorporated societies for the ensuing year: Major-General Schaw, Mr. McKerrow, and Mr. S. Percy Smith.

The adjourned discussion on Sir James Hector's paper on the outlying islands south of New Zealand was opened by Sir W. Buller, who said that for those who have not had an opportunity of visiting those islands it was almost impossible to form any correct idea on the subject without such a fine map as that now exhibited. Even Sir Joseph Hooker, in acknowledging receipt of an author's copy of his (Sir Walter's) "Illustrations of Darwinism," and discussing its argument, had complained that, through the want of such a map, he often found himself in a difficulty about locality. The theory which Sir James Hector had put before the meeting to account for the present configuration of the Auckland Islands was, to his mind, most interesting and suggestive, and seemed to explain much that was obscure before. The information also about the deep-sea soundings, showing the existence of an elevated plateau over an entirely new area, was most valuable, as helping to define the true limits of the much-discussed sunken continent of Antarctica. The lecturer's observations on the geology of the isolated island areas, and his remarks on the zoology and botany, were also very important. In fact, the lecture was bristling

with points, and was replete with interest. In the observations he was about to offer he would confine himself to the zoological aspect of the question, and, leaving the mammals—the whales and the seals—alone for the present, he would limit his remarks to the birds. And before proceeding further he would call attention to the collection of albatroses on the table, ten in number, representing six species at different ages, as he would have frequent occasion to refer to them in the course of his remarks. He explained that they were part of a collection which Sir James Hector was forming in the Museum, which was to comprise all the known albatroses of the Southern Hemisphere, and that these were to be grouped together according to the method pursued in the British Museum. Another case would contain all the known penguins in this hemisphere; and the other birds would be similarly arranged in natural groups. Directing attention to the mounting of the albatroses on exhibition, Sir Walter mentioned that two of them had been set up by Mr. Cullingford, an expert taxidermist in England, and the fact that the others set up by the local taxidermist (Mr. Yuill) compared so well with these reflected very great credit on his skill. The geographical distribution of the various species of albatros (as also of penguins and other oceanic birds) among these islands was a very curious feature. Speaking generally, each island or group of islands has its own albatros, its own penguin, its own cormorant, and its own set of small petrels. Thus, the Snares are inhabited by that beautiful albatros, or mollymawk, with a bright-yellow strip along the ridge of the bill—the bird which it had been our habit to call *Diomedea culminata* till it was differentiated by our great authority on petrels, Mr. Osbert Salvin, and named by Rothschild *Diomedea bulleri* in compliment to himself. The Auckland Islands are the resort, in countless numbers, of the wandering albatros (*Diomedea exulans*), except that there is a small colony of another species about which he would have something to say later on. Antipodes Island is the home of the beautiful yellow-billed albatros (*Diomedea melanophrys*). Campbell Island is the great breeding-place of the royal albatros, originally described by the speaker under the name of *Diomedea regia*,—the noblest member of the whole group. Curiously enough, although this is the recognised resort of that fine species, there is a small colony of them on the Auckland Islands, living apart from the wandering albatros, and breeding at a somewhat later date. The royal albatros, as he explained, is distinguishable from *Diomedea exulans* by its larger size, by its white head and neck, without any patch on the vertex or crown, by the larger amount of white on the wings, and by having jet-black eyelids, those of the other species being purple. Then we come to the Bounties. Here the dominant species is the beautiful mollymawk now known as *Diomedea salvini*, but confounded for a long time with the shy albatros (*Diomedea cauta*) of the Australian seas. What species of albatros it is that inhabits Macquarie Island he had not been able to determine with certainty, no specimens having been brought from that locality. The sooty albatros, which really belongs to another genus, is more diffuse in its range, a few pairs turning up from time to time on each of the groups of islands. So again with the penguins. On the Snares we have the thick-billed penguin (*Eudyptes pachyrhynchus*), the same as that frequenting the coasts of New Zealand. On the Auckland Islands we have the large and handsome *Eudyptes antipodum*. Antipodes Island is the home of the fine species which he had dedicated to Dr. Sclater (*Eudyptes sclateri*), and the smaller and well-known *Eudyptes chrysocome*. On Campbell Island we appear to have the latter alone, and on the Bounties probably both of them. On Macquarie Island, on the other hand, there are four species not met with elsewhere. First of all, there is the king-penguin (*Aptenodytes longirostris*), represented in tens of thousands in the beautiful enlarged photographs exhibited

by Sir James Hector at last meeting—a bird so abundant on those islands that the boiling of them down for their fat has become a well-established and lucrative business; secondly, the yellow-crowned royal penguin (*Eudyptes chrysolophus*), being the same as *Eudyptes schlegeli* of Dr. Finsch; the extremely rare black penguin (*Eudyptes atratus*), of which only two examples have been recorded; and, lastly, a smaller penguin belonging to another group, having a slender bill, and known as *Pygoscelis tæniatus*. But the fact that he wished to emphasize was this: that each of the islands, or groups of islands, is a nursery for particular species of oceanic birds which appear never to interfere with each other's sanctuary. Nothing is more wonderful in the romance of natural history than the unerring instinct with which these birds, year after year, after measureless wanderings on the face of the ocean, find their way back, at the appointed time, to their common breeding-place. Albatroses and penguins spend about ten months of the year at sea. The albatros sweeps the vast waste of waters with its broad, never-tiring pinions, and rests and sleeps on the bosom of the deep. It never leaves the sea till the breeding-season commences, when the reproductive instinct impels it to seek its rocky cradle; and then, without chart or compass, and apparently without difficulty, it sails direct to its old breeding-place—a mere rock, so to speak, in the wilderness of waters. In the case of the penguins this natural instinct is even more wonderful. The penguin spends nearly the whole of its life in the water, which is its natural element; for, not being furnished with anything but rudimentary wings, or flippers, it is unable to fly. For purposes of reproduction it finds its way back to its island nursery when nature prompts it to undertake that duty. It may be said of the albatros that it can mount in the air and take its bearings when looking for its island asylum. But not so with the penguin. Owing to its conditions of existence it is unable to leave the water, and, swimming on the surface, can, at the best, see only a few yards ahead. And yet, with unerring precision, each species of penguin goes straight back to its particular island sanctuary, and to its own community. As an illustration of the truly oceanic character of a penguin's life, he reminded the Society that at a former meeting, some two or three years ago, he had exhibited the foot of a penguin, taken from a fresh bird, in which a bunch of barnacles had become attached to the toes through long immersion in sea-water—this, too, in spite of the every-day wear-and-tear of active life. Then, again, several of the groups of islands can claim a distinctive species of cormorant; as, for example, *Phalacrocorax colensoi*, on the Auckland Islands, and *Phalacrocorax nycthemerus*, on Campbell Island; and of the smaller species of oceanic petrels each has its own favourite breeding-ground, and never interferes with that of the others. There are other birds that present an interesting study in these islands. For example, there is a snipe, the closely-allied species of which are very sedentary in their habits. Thus, the pretty little snipe described by himself some twenty years ago as *Gallinago pusilla* (owing to the smallness of its size) inhabits the Chatham Islands, where Mr. Rothschild has discovered a second species. At the Snares we have *Gallinago huegeli*, so named in honour of Baron von Hügel, the discoverer. At the Auckland Islands we have the well-known *Gallinago aucklandica*, one of the finest of the group; and at Antipodes Island, *Gallinago tristrami* of Rothschild. Then, again, at the Auckland Islands there is the curious flightless duck (*Nesonetta aucklandica*), which is found nowhere else. It has been suggested, with some show of truth, by Count Salvadori that this is a direct descendant from *Anas chlorotis* of New Zealand, the wings having become atrophied and aborted through the change of environment, the duck requiring no longer to fly, but rather to scale the rocks which enclose its habitat by climbing, a faculty in which it excels. He also mentioned that Sir James Hector had sent to Professor Newton specimens

of this flightless duck in spirit, whilst he (Sir Walter) had sent specimens of the New Zealand bird, also in spirit: so that we might expect before long to hear more on this interesting subject. All we can do at present is to await patiently the report of our leading comparative anatomist on the question raised by Count Salvadori, which has an important bearing on the theory of evolution. There is another endemic form—the Auckland Island merganser (*Mergus australis*)—a form which is not met with in any other part of the Southern Hemisphere; also a peculiar species of rail (*Rallus muelleri*), so called in compliment to Baron von Mueller—a bird so rare that there is only one known example, in the museum at Stuttgart. On Antipodes Island there are two species of parrakeet, living side by side, and found nowhere else; and an endemic species of ground-pipit (*Anthus steindachneri*). On the Snares there is a species of fern-bird (*Sphenœacus caudatus*) very similar to the one inhabiting New Zealand, but quite distinct both from that and from *Sphenœacus rufescens* of the Chatham Islands. He said he might go on enumerating cases of this kind without end; but he had said enough to show that these islands present for our consideration some important zoo-geographical problems. He felt, therefore, that the Society was indebted to Sir James Hector for having brought the subject prominently forward by his interesting and instructive lecture.

Mr. Travers said that Mr. Moseley, in his notes during the voyage of the "Challenger," mentions this habit of the penguin keeping its egg in a pouch, and adds that the albatros and the mollymawk do the same; but with this latter he did not agree, as they have good nests to hold the eggs. He understood that the penguin sometimes laid two eggs.

Mr. H. Travers (with permission) gave some information about the habits of the birds on these islands. He said that the so called flightless duck did fly to a slight extent; the penguin lays two eggs, but only hatches one, the same as the gannets; the albatros has no pouch, but the penguin has.

Mr. Harding said this statement of these birds finding their way back to their own particular island is most interesting, and bears out what has often been said about animal instinct: they possess senses of which we have no idea. It is common to all the animal creation. He gave instances of this instinct, and particularly mentioned the bee and the limpet finding its way back from long distances to its own hive or rock.

Mr. Hustwick asked if the young birds remained on the nests until the return of the parents, and, if so, how do they live.

Mr. Richardson thought these birds were useful in getting rid of the octopus.

The President said that the most interesting portions of Sir James Hector's paper were those in which he embodied the novel and important conclusions respecting the origin of the Auckland Islands, and the new information respecting the elevated sea-bottom between the Auckland and Campbell Islands and New Zealand: the latter especially removed many difficulties that had been felt with regard to the distribution of the plants and animals found on the islands. A similar state of things existed between the North Cape and the Three Kings Islands, but it had long been held—erroneously, as it now appeared—that the sea-bottom between New Zealand and the Auckland Islands was only to be touched at a great depth. Although the remarks on the birds of the islands had been well discussed, he should like to ask the author if he could offer any explanation of the causes of the differences in the nests of the albatros on different islands. On Antipodes he came across numerous nests which were very roughly finished and of rather small size, while on the other islands they were symmetrical and extremely regular. Were the dif-

ferences to be seen in this particular characteristic of the species, or were the poorly-finished nests to be considered the first efforts of inexperienced builders? If so, it would be at variance with what was exhibited by birds in general, the first nest being usually as perfect as those constructed at a later period of life. He intended to have made some remarks on the botany of the antarctic islands, but the late period of the evening would only allow of a cursory reference to the subject. These islands were remarkable for the large number of endemic plants with beautiful flowers and striking foliage. The genus *Pleurophyllum*, of which there were three species, all of great beauty, was absolutely restricted to these islands, and constituted one of the most interesting features of the flora. *Stilbocarpa polaris*, with its bold foliage, waxy flowers, and glossy fruit was found on all the islands, but nowhere else. Two handsome species of *Ligusticum*, with beautiful foliage and large umbels of red flowers, were equally attractive, although in a different way. *Celmisia vernicosa*, one of the most beautiful species of a beautiful genus, is not found elsewhere; so also the lustrous *Anthericum rossii*, with its diœcious golden flowers arranged in densely-crowded erect racemes. One other plant must be mentioned, although it will by no means exhaust the list—the beautiful *Veronica benthami*, with its glossy foliage and large flowers of azure blue. Now, it is most remarkable that this assemblage of conspicuous plants with beautiful flowers should be crowded on these rocky islands, the climate of which is more severe than that of any part of New Zealand proper. There is no other instance in temperate climates where so many striking and beautiful plants are to be found in such a limited space; and it is most noteworthy that, with the exception of several ferns of wide distribution, none of the plants to be found on the islands exhibit any great amount of variation; they are remarkably uniform in appearance, and this uniformity contrasts strongly with the wide variation exhibited by large portions of the New Zealand flora. He was glad to have the opportunity of expressing his indebtedness to Sir J. Hector for the large amount of information contained in the paper which had been laid before them.

Sir James Hector, in reply, thanked the members for the kindness with which they had received his lecture. Since last meeting the large map now exhibited, showing the physical features of the Southern Hemisphere, had been prepared with the skilful assistance of Mr. Pierard. He trusted that it would be of service to illustrate many future discussions. With reference to the remarks of the President and Sir W. Buller regarding the singular distribution of birds and plants among the islands, he said that the differences were such as to show that the islands were remnants of an extensive land-area that had been dissevered long enough to permit of specific characters springing up, and yet he had been able to show that some at least belong to very recent geological formations. The discovery of fossils last year on Seymour Island, near the antarctic circle—which appear to indicate a similar assemblage to that which characterizes the Upper Eocene of New Zealand, and is always held to indicate conditions warmer than those of the New Zealand seas at the present time—is a remarkably significant fact. It is very tantalising to have such a large area of the globe unexplored. Without any special appliances, Captain Cook, on four occasions, almost reached the shore of the antarctic land 120 years ago. Fifty years ago, also with sailing-ships, Ross was the first to land. Twenty-one years ago the "Challenger," without any special outfit for resisting the inclement conditions, brought back a wealth of interesting information. With modern appliances, and the great experience that has now been gained in ice-bound navigation, there should be no difficulty in fitting out a suitable expedition. In reply to the President, he said that the albatros nests differ very much in size and form, chiefly owing to their being used over and over again, and

each year receiving a fresh addition of cementing matter. The hatching process of the penguin is quite a different and a more difficult problem—which is, how a bird with a rigid body and hard feathers can lay its egg on a round boulder and sit on top of it. The photograph on the screen explained how this was done.

*Paper.*—"On a New Species of Luminous Fish (*Polyipnus kirkii*)," by Sir J. Hector. Specimen found by Mr. H. B. Kirk, M.A., and exhibited.

TENTH MEETING: *18th December, 1895.*

Mr. T. Kirk, F.L.S., President, in the chair.

*Papers.*—1. "On Iron from the Titaniferous Sand of New Zealand," by E. Purser; communicated by Mr. T. H. Hustwick (*Transactions*, p. 689); with models of machinery used in manufacture of the iron.

Major-General Schaw said that this ironsand was sometimes called "magnetic," sometimes "titanic" or "titaniferous." He held that the term "magnetic" was a misnomer, for it meant that each grain of the iron in the mixed sand was itself a permanent magnet, and this experiment proved it was not. It had been mentioned that at Onehunga a system of separating the iron particles from the other particles mixed with them in the sand had been used, in which electro-magnets were employed. These, when magnetized by an electric current, picked up the iron particles, and, when demagnetized by breaking the current, dropped the iron particles. Had the iron particles been themselves magnetic they would have remained attached to the soft iron core of the electro magnet by their own magnetic attraction; but they did not—hence they were not themselves magnetic. Also, if they had been steel, not iron, they would have been permanently magnetized by contact with the electro-magnet, and would not have dropped off when the current ceased. Therefore, the iron particles in the sand were simply iron, and neither magnetic nor steel. These iron particles were, however, in a peculiar condition: they would not rust, *i.e.*, form the red oxide, as ordinary iron does. In fact, they were already saturated with oxygen, and could take no more into combination. How or why they had been so combined he could not say; but he had been informed that the cause was the presence of a small percentage of titanium combined with the iron in each particle. He should be glad to know if this was the case or not. If it was not—if each particle of iron was pure iron combined with oxygen, and the titanium and other impurities were separate grains, mixed mechanically in the sand, it seemed to him that the process had a very good prospect of ultimate success; but if the titanium was in greater or less proportions combined with the iron also, then he feared that the difficulties would be found to be much greater, as it was, he believed, possible that different samples of the sand would be found to contain different percentages of combined titanium in the iron particles in addition to varying proportions of mixed impurities in the sand. If it could be established as a fact that always the iron grains in the sand were pure iron combined with oxygen, the prospect seemed to him most hopeful.

Sir James Hector said that the question of how to reduce ironsand had occupied much attention, and in many countries some of the finest steel had been manufactured from it for thousands of years, especially in India, but by a slow process that would be too expensive with the cost of

labour in this colony. Fifty or sixty patents have been obtained for utilising ironsand, Mr. Mushet alone having over twenty patent rights secured, some of them expressly for the Taranaki sand. Works have been erected in many places—as, for instance, at Moisie on the Gulf of St. Lawrence, and at Taranaki and Onehunga, but none had been commercially successful. Several magnetic separators had been invented and used. He had seen one at work at Onehunga several years ago. But the difficulty is that the grains of ironsand often consist of different minerals, some of which are deleterious to the iron: but if the magnetic ore which is alone pure predominates, then the whole grain is lifted by the magnet and passed on to the smelting-furnace. The only novelty in Mr. Purser's process, so far as he knew, is the employment of glue as a cementing material, in order to bind the sand so that it can stand the blast of the reducing-furnace. Without a search it would not be safe to conclude as to whether his idea had been forestalled; but it was a good idea, and was, in fact, an improved application of the Indian cementation process, only the reducing-power of glue as compared with moist charcoal powder would be very small, and special fuel for reduction of the oxide to the metallic state would have to be employed. The whole matter is one for careful experiment in order to test the cost of production compared with the market-value of the product. He had himself examined the results obtained at the Hinui works, near Taranaki, and they were not favourable. Mr. Purser's process is certainly a great improvement, and he wished it every success; but the estimate of cost which had been given required verification, and, what is more important, the purity and value of the metal produced on a large scale of working must be placed beyond doubt. Cast steel should be aimed at; but if there is the least trace of titanium in it it may prove worthless for some kinds of work.

Mr. Maskell said that there had been many processes invented for dealing with this so called ironsand, but none appeared to have succeeded, and it did not seem to him that the present one promised better than the others.

Mr. Hustwick considered that the difficulties in connection with this sand were nearer solution than ever before. If the impurities can be removed on a small scale they can also be removed on a large scale. There was a distinct advantage in having steel that is made direct, as it is so much used now.

Mr. Purser did not think that sands from other countries could compete with the New Zealand sand, which is richer in ore, and our climate is so much more favourable. He did not think there would be much difficulty in getting rid of the titanium: it is not magnetic, and would not be taken up. Mr. Purser concluded by describing the process of making the briquette, and explained how he arrived at his estimate of cost.

2. "On an Eclipse Phenomenon," by Major-General Schaw.

3. "On a Wellington Weather Prognostic," by Major-General Schaw. (*Transactions*, p. 71.)

Sir James Hector said that the remarks made by General Schaw *re* the eclipse do not apply only to eclipses, but would also apply to any light. In answer to Mr. Maskell, he explained on the blackboard how the barometer falls with a north-west wind and rises with a south wind during the eastward progress of a cyclonic circulation the limit of which lies to the south of Wellington.

General Schaw, in reply, said that the answer to Mr. Maskell's question was given in every modern book on meteorology, as explained by Sir J. Hector.

4. "Further Coccid Notes," by W. M. Maskell. (*Transactions*, p. 380.)

5. "On New Zealand Sponges," by H. B. Kirk, M.A. (*Transactions*, p. 205.)

Sir James Hector exhibited a series of sketches by Mr. Deverill of the islands south of New Zealand, kindly lent by Mr. S. Percy Smith, Surveyor-General.

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Annual Meeting: *26th February, 1896.*

Mr. Maskell in the chair.

Abstract of Annual Report.

The balance-sheet set forth the receipts for the year (including the balance brought forward, £54 11s. 6d.) to be £162 14s. 6d., the expenditure £95 16s. 10d., and the balance £66 17s. 8d., to which has to be added £25 5s. 6d., lodged in the bank at interest, making a total balance of £92 3s. 2d.

Election of Officers for 1896.—*President*—W. T. L. Travers, F.L.S.; *Vice-presidents*—R. C. Harding, Sir J. Hector, K.C.M.G., M.D., F.R.S.; *Council*—E. Tregear, F.R.G.S., Major-General Schaw, C.B., R.E., Sir W. Buller, K.C.M.G., F.R.S., H. Farquhar, W. M. Maskell, G. V. Hudson, F.E.S., Thomas Kirk, F.L.S.; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Sir James Hector moved a vote of thanks to the retiring President, Mr. Kirk, and pointed out how ably he had carried out the duties of the office during a most successful year. He drew attention to the valuable work he, Mr. Kirk, was at present engaged on—viz., a work on the botany of New Zealand, which was so much needed by students and others working on this branch of science.

Mr. Travers seconded, and the vote was carried.

*Papers.*—1. "On the Products of a Ballast-heap," by T. Kirk, F.L.S. (*Transactions*, p. 501.)

Mr. Travers said that he had often pointed out before that these weeds came from wardian cases sent out here, and precautions should be taken to prevent their introduction.

Mr. Hustwick said that a paper of this kind would be of great service in warning persons from spreading noxious weeds in this country.

Mr. Richardson said that the large growth of fennel to be found all over the Town of Wellington ought to be cleared away, as it was anything but pleasant.

Mr. Maskell said this plant was in abundance near Grant Road.

2. "Further Notes on Coccids (No. 2)," by W. M. Maskell. (*Transactions*, p. 380.)

3. "On the *Aleurodidæ*," by W. M. Maskell. (*Transactions*, p. 411.)

Mr. Hudson considered this paper on the *Aleurodidæ* a most valuable contribution. He was glad that Mr. Maskell had turned his attention to this interesting family. There were two species of moths in England only distinguished, like the *Aleurodidæ*, in the immature stage.

Sir J. Hector said this was an important paper. Numbers of trees were being destroyed by these minute insects, and the curious thing was that they could only be recognised in the immature state; it was the reverse of what was usual.

Mr. Travers said that Captain Hutton had pointed out that the Planarians are only distinguished by their colours. They also differ in the immature stage where they do not in the perfect insect.

Mr. Maskell, in reply, said that possibly there may be differences in the full-grown form, but, if so, it was exceedingly difficult to distinguish them. He said that in hot weather these insects were most numerous, and there was only one generation in the year.

4. "On New Zealand *Cicadidæ*," by W. F. Kirby, F.L.S.; communicated by G. V. Hudson. (*Transactions*, p. 454.)

5. "Notes on J. S. Maclaurin's Paper on the Action of Potassium-cyanide Solution," by W. Skey; communicated by Sir J. Hector. (*Transactions*, p. 708.)

6. "On New Zealand *Hydroida*," by H. Farquhar. (*Transactions*, p. 459.)

The following exhibits were shown by Sir J. Hector, and remarks made on them: (1.) Elephant-fish (*Callorhynchus antarcticus*), from Wellington Harbour. (2.) Jaw-bone of elephant-fish, from Wellington Harbour. (3.) Eggs of elephant-fish, from Wellington Harbour. (4.) Spawn of elephant-fish (showing embryo), from Wellington Harbour. (5.) Fossil *Callorhynchus*, from Amuri Bluff. (6.) Clay-deposit containing mercury, from Russell. (7.) Common oyster (*Ostrea edulis*), from Kaipara Harbour. (8.) Rock-oyster (*Ostrea glomerata*), from Kaipara Harbour. (9.) Molybdenite, from Puhipuhi. (10.) Argentiferous galena, from Puhipuhi. (11.) Ore containing copper, lead, zinc, and silver, from Whangarei. (12.) Silver-ore, from Russell. (13.) Coal, from Hikurangi. (14.) Iridescent coal, from Hikurangi. (15.) *Cheimarrichthys forsteri* (fresh-water fish), from Inglewood.

7. "On *Zannichellia* and *Lepilæna* in New Zealand," by T. Kirk, F.L.S. (*Transactions*, p. 498.)

8. "An Undescribed Palm-lily," by T. Kirk, F.L.S. (*Transactions*, p. 508.)

9. "On the Genus *Hymenanthera*," by T. Kirk, F.L.S. (*Transactions*, p. 510.)

10. "Notes on Veronica, with Description of New Species," by T. Kirk, F.L.S. (*Transactions*, p. 515.)

# AUCKLAND INSTITUTE.

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FIRST MEETING: *3rd June, 1895.*

Professor A. P. Thomas, F.L.S., President, in the chair.

*New Members.*—R. A. Carr, R. W. Duthie, S. Danneford, Rev. J. T. Penfold, F.G.S., J. W. Tibbs, M.A.

The President delivered the anniversary address.

ABSTRACT.

The President prefaced his address by speaking of various local matters of particular interest to members of the Institute. All would be glad to hear that the ground was clear for the acquisition of the Little Barrier Island, and its setting on one side for the preservation of the fauna and flora of New Zealand—a project initiated by the Institute in 1886. He expressed the hope that, as soon as the purchase was completed, the Government would take steps to remove the Maoris now living on the island, and would also prevent the visits of unscrupulous collectors. The unsuitability of the present lecture-room for the purposes of the Society was dwelt upon. Some members were of opinion that the diffusion of scientific knowledge by means of meetings, popular lectures, &c., was no essential part of the duties of the Institute. He did not agree with these, but considered they should do all in their power to make their meetings more attractive and instructive. But this implied a larger room, and the possession of suitable apparatus for illustrating the lectures or papers read. He trusted that the matter would be fully considered by the Council during the coming session. He then passed on to the subject he had selected for his address, "Life and Crystals": the phenomena presented by life, and the phenomena presented by inorganic matter, particularly with regard to structure and growth. The structure of the living cell, and its component parts, was described with considerable detail; as also the structure and growth of crystals. The address was copiously illustrated with diagrams, many of which had been specially prepared for the occasion.

SECOND MEETING: *17th June, 1895.*

Professor A. P. Thomas, F.L.S., President, in the chair.

Professor F. D. Brown gave a popular lecture on "Argon, the Newly-discovered Constituent of the Air."

ABSTRACT.

The lecturer alluded to the paper read before the Royal Society on 31st January by Lord Rayleigh and Professor Ramsay, in which the details of the discovery were first made public, and gave a synopsis of the chief facts of interest contained therein. He experimentally

showed how argon could be obtained by passing atmospheric nitrogen backwards and forwards from one gas-holder to another over red-hot magnesium, whereby the nitrogen was slowly taken up as magnesium nitride, while there remained a residue of unabsorbed gas; and he also described the other methods which have been followed to obtain argon.

At the close of the lecture a vote of thanks was proposed by the Vice-president (Mr. J. H. Upton) and carried by acclamation.

### Third Meeting: *1st July, 1895.*

Professor A. P. Thomas, F.L.S., President, in the chair.

*New Member.*—Professor H. W. Segar.

*Paper.*—"Social Problems: Poverty and Unemployed Labour in Civilised Communities," by F. G. Ewington.

### Fourth Meeting: *15th July, 1895.*

Professor A. P. Thomas, President, in the chair.

The Right Rev. W. G. Cowie, D.D., Bishop of Auckland, gave a popular lecture on "The Recent Chitral Difficulty, and the Future of the Country between Western Afghanistan and the Indus."

### Fifth Meeting: *5th August, 1895.*

Professor A. P. Thomas, President, in the chair.

*Papers.*—1. "Note on a Volcanic Outburst on Sunday Island in 1814," by S. Percy Smith. (*Transactions*, p. 47.)

2. "The History of Otakanini Pa, Kaipara" (translated from the Maori of Hami Tewaewae), by S. Percy Smith. (*Transactions*, p. 41.)

3. "The Training of Teachers for Primary Schools," by the Rev. J. Bates. (*Transactions*, p. 111.)

A lengthy discussion arose, in which Mr. Petrie, Chief Inspector of Schools, Mr. Upton, Mr. Stewart, Mr. G. Aickin, and the President took part.

### Sixth Meeting: *19th August, 1895.*

Professor A. P. Thomas, President, in the chair.

Professor C. W. Egerton gave a popular lecture on "The Dawn of the English Drama."

Abstract.

The lecturer said the English drama was the slow and gradual development of many centuries. It had its origin in the ritual services

of the mediæval Church, and in the first instance its object was to stir the emotions and purify the morals of the faithful by bringing home to them the facts of sacred history with the greatest possible vividness. At the outset, sacred dramas were enacted within the walls of the church itself. Indeed, the form of service itself was, as a French writer has noticed, "nothing but a long divine spectacle." The lecturer then gave a description of the old miracle-plays, and an estimate of their relation to the life of the fourteenth, fifteenth, and sixteenth centuries. He then noticed the "moralities," or allegorical plays, and farcical interludes, ending with an account of the genesis of the regular English drama, as represented by Shakespeare's immediate predecessors.

## Seventh Meeting: *2nd September, 1895.*

Professor A. P. Thomas, President, in the chair.

*Papers.*—1. "Two Coming Eclipses," by Professor H. W. Segar.

Abstract.

This paper gave an account of an eclipse of the moon (partial) to come off on the evening of the 3rd September, and a partial eclipse of the sun to take place on the 19th September.

2. "Browning's 'Vision of Life,'" by E. A. Mackechnie.

Abstract.

The author commenced by stating that, although the high excellence of Browning's poetry was beyond dispute, yet he could not be called popular, and his works were not widely read. This is in great measure due to the subject-matter of his poems, which is chiefly psychological. Few people take an absorbing interest in such studies; and it is this want of interest in the subject, rather than obscure phraseology, which is the true reason why Browning's writings are not more often read. The writer then proceeded to illustrate the views which Browning held of life, and of man's duty to himself and others, giving frequent quotations from his poems in support of his statements. He considered that Browning possessed in no ordinary degree the scientific spirit of patient research and minute analysis. He threw himself, as it were, into the very mind which he pourtrays, showing it from within, and laying bare its thoughts, passions, and secrets. It is this study which lent interest to his life, and to which we are indebted for those psychological pictures which give the workings of a man's soul. Tennyson has often been called "the poet of the age," and, from the large circle of his readers, the claim is perhaps just. But the music of his verse, like much other bygone music, having supplied the requirements of the age, will probably cease to command attention. But the admirers of Browning claim for him a more enduring fame. He depicts our thoughts, our loves and hates; the aspirations of our spiritual nature; the trials and disappointments of this life,—all, in fact, that makes humanity; he has not inaptly been termed "the dramatist of the soul," and as such his admirers anticipate that he will take a position in the world's estimation second only to Shakespeare.

EIGHTH MEETING: *16th September, 1895.*

Professor A. P. Thomas, President, in the chair.

Mr. E. W. Payton gave a popular lecture on "Art and Photography."

ABSTRACT.

The lecturer discussed the claims of photography to a place among the fine arts, treating the question from the point of view of both artist and photographer. He described the chief points of difference between the works of the artist and the photographer, particularising the excellencies and defects of both. The value of a knowledge of photography to an artist, and its dangers, and the value of an artistic training to a photographer, were both fully treated of. The lecture was illustrated with a large number of lantern-slides prepared from the best works of the most celebrated artists of Europe, and from photographs of high merit.

NINTH MEETING: *7th October, 1895.*

Professor A. P. Thomas, President, in the chair.

*Papers.*—1. "Description of Three New Species of Native Plants," by D. Petrie, F.L.S. (*Transactions*, p. 538.)

2. "On Some Additions to the New Zealand Flora," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 534.)

3. "The Ancient Tribe Te Panenehu," by Captain Gilbert Mair. (*Transactions*, p. 36.)

4. "The Railway and its Place in Social Economy," by Dr. A. G. Purchas. (*Transactions*, p. 59.)

TENTH MEETING: *21st October, 1895.*

Professor A. P. Thomas, F.L.S., President, in the chair.

The Rev. Canon Bates gave a popular lecture on "Democracy." (*Transactions*, p. 97.)

ANNUAL MEETING: *24th February, 1896.*

Mr. J. H. Upton, President, in the chair.

*Paper.*—"The Action of Potassium Cyanide upon Gold," by J. S. Maclaurin. (*Transactions*, p. 695.)

ABSTRACT OF ANNUAL REPORT.

The number of members is 172, being an increase of one on former year. Those removed by death are Mr. D. B. Cruickshank, whose association with the Institute dated almost from its foundation; and Mr. W. P. Moat, well-known in Auckland from his lengthened services on the Board of Education.

Ten meetings were held during the year, at which seventeen papers were read.

The register kept on Sundays shows that 10,154 persons entered the Museum on that day, or an average of 191; the daily average on week-days being about 100.

Numerous donations have been made to the Museum, but the Council regret that, owing to being unable to employ a taxidermist, most of the additions in the Zoological Department have had to be packed away, and some had to be declined. The Council specially refer to the gift made by the chief Hami te Waewae of a carved post or "tiki" from Otakanini Pa, Kaipara, a fortress well known in ancient Maori history. Other donations of special value have been made by Mr. T. Coates, Mr. F. D. Fenton, Mr. T. C. Tims, and Mr. E. H. Woledge.

The rearrangement and labelling of the minerals has been completed; the collection of kauri-gum has been rearranged and made ready for labelling; duplicate and unexhibited specimens of all classes have been carefully overhauled and repacked, and several sets have been withdrawn for exchange; several minor changes have been made in the arrangement of the ethnological collections.

For some years past the eastern end of the main hall had been exceedingly damp during winter and spring, and of late the south wall of the Ethnological Hall had shown the same fault. After consulting several authorities, it was decided to treat the exterior of the walls with Szerelmey stone liquid, which has been used with good results on several important public buildings at Home. The importation of the liquid and its proper application have proved rather costly, but the walls remained perfectly dry through last winter and spring.

An expenditure of £50 has been incurred during the year in the purchase of standard scientific works. Special attention is drawn to the publications of the Egyptian Exploration Fund, the Royal Society's Catalogue of Scientific Papers, and the recently issued Index Kewensis.

The Council have pleasure in alluding to a donation made by Mr. D. Rough, the first harbourmaster of Auckland, of seven water-colour sketches of incidents connected with the early days of Auckland, forming an interesting and welcome addition to the collection bearing on the early history of the colony.

Very disquieting rumours have been prevalent in Auckland respecting the position of matters on the Little Barrier Island. It has been stated that, so far from the island having been kept as a strict preserve for the rarer members of the New Zealand fauna, large numbers of birds have been slaughtered and sold—some to people in New Zealand, and others to collectors in England. It is difficult to understand how such a practice could be carried on without the knowledge of the caretaker, or the assistance of the Maoris resident on the island; but the rumours are so circumstantial, and of such independent origin, that they probably rest on a basis of truth. The matter was brought under the notice of Parliament, and an investigation was ordered; which, however, does not seem to have resulted in either proving or disproving the statements which have been made. It is satisfactory to know, however, that the Maoris residing on the island have been removed; for it cannot be denied that their presence was a continual source of danger, either from the risk that the high prices offered by dealers might tempt them to start collecting, or by keeping up a regular means of communication between the island and the mainland, and thus making the visits of collectors easy. The Council are of opinion that there should be no resident on the island except the caretaker, who should be a man of proved honesty and integrity, and who should be armed with full powers to prevent unauthorised persons from landing.

The balance-sheet shows that the total revenue, excluding the previous year's balance of £78 14s. 4d., was £877 18s. 8d. This is a somewhat smaller amount than was received during 1894–95, a temporary delay in the payment of one of the chief items of revenue having prevented its inclusion in the annual statement of accounts. From the same cause the receipts from the invested funds of the Costley bequest show a diminution, the amount for this year being £388 9s. 7d., against £474 12s. 2d. for the previous year. The rents and interest derived from the Museum endowment have yielded £340, almost exactly the same sum as that credited during 1894–95. Members' subscriptions amount to £132 6s., being slightly in excess of the previous year's receipts. The increase is gratifying in view of the fact that this source of income has progressively declined since 1882. The total expenditure has been £890 18s. 6d., leaving a credit balance of £60 9s. 1d. The invested funds of the society are in a satisfactory state. The total amount at the present time is £13,145, showing an increase of £800 during the year. With the exception of about £900, the whole of this sum is invested in mortgage on freehold property.

Election of Officers for 1896.—*President*—D. Petrie, M.A., F.L.S.; *Vice-presidents*—Prof. A. P. Thomas, F.L.S., J. H. Upton; *Council*—G. Aickin, J. Batger, W. Berry, Professor Brown, F.D., F.C.S., C. Cooper, E. A. Mackechnie, T. Peacock, J. A. Pond, F.C.S., Rev. A. G. Purchas, M.R.C.S.Eng., T. H. Smith, J. Stewart, C.E.; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Curator*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

# PHILOSOPHICAL INSTITUTE OF CANTERBURY.

FIRST MEETING: *1st May, 1895.*

Professor Dendy, D.Sc., President, in the chair.

*Papers.*—1. "On a Rare Native Butterfly" (*Dodonidia helmsi*), by P. Marshall, M.A. (*Transactions*, p. 312.)

2. "On the True Instincts of Animals," by C. W. Purnell. (*Transactions*, p. 27.)

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SECOND MEETING: *5th June, 1895.*

Professor Dendy, D.Sc., President, in the chair.

*New Members.*—W. W. Smith, L. Cockayne.

*Paper.*—"On the Gall-flies of New Zealand," by P. Marshall, M.A. (*Transactions*, p. 216.)

THIRD MEETING: *3rd July, 1895.*

Professor Dendy, D.Sc., President, in the chair.

*New Member.*—J. A. Erskine, M.A.

*Papers.*—1. "On the Behaviour of Two Wells at the Canterbury Museum," by Captain Hutton, F.R.S. (*Transactions*, p. 654.)

2. "Notes on New Zealand Land Planarians, Part II.," by Dr. Dendy. (*Transactions*, p. 210.)

3. "Notes on New Zealand Mosses," by R. Brown. (*Transactions*, p. 531.)

4. "On a New Zealand Land Nemertine," by Dr. Dendy. (*Transactions*, p. 214.)

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FOURTH MEETING: *7th August, 1895.*

Professor Dendy, D.Sc., President, in the chair.

*New Members.*—Professor R. J. Scott, Dr. Lomax-Smith.

*Papers.*—1. "On Magnetic Viscosity," by E. Rutherford, M.A. (*Transactions*, p. 182.)

2. "Periodimeter, for Measuring Periods of Rapidly-oscillating Currents," by E. Rutherford, M.A.

3. "On a Deposit of Moa-bones at Kapua," by Captain Hutton, F.R.S. (*Transactions*, p. 627.)

4. "On the Moa-bones from Enfield," by Captain Hutton, F.R.S. (*Transactions*, p. 645.)

5. "On the Discovery of Moa-remains at Riverton Beach," by C. A. Ewen; communicated by Captain Hutton, F.R.S. (*Transactions*, p. 651.)

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Special General Meeting: *2nd October, 1895.*

Professor Dendy, D.Sc., President, in the chair.

It was decided to alter the date of the annual meeting to the first Wednesday in April; also the beginning of the financial year to 1st January.

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Fifth Meeting: *2nd October 1895.*

Professor Dendy, D.Sc., President, in the chair.

*New Member.*—Dr. Murray-Aynsley.

*Papers.*—1. "Notes on some New Zealand Fishes," by Captain Hutton, F.R.S. (*Transactions*, p. 314.)

2. "On the Habits of New Zealand Ants," by W. W. Smith. (*Transactions*, p. 468.)

3. "Notes on some Rocks from the Kermadec Islands," by R. Speight, M.A. (*Transactions*, p. 625.)

4. "Notes on New Zealand Mollusca," by H. Suter; communicated by Captain Hutton. (*Transactions*, p. 319.)

Mr. A. C. Murray-Aynsley forwarded a letter, in which he stated that the black rat (*Mus rattus*) was common at Opawa, especially during the fruit season. He also sent a specimen, which was exhibited. Captain Hutton stated that this was the first recorded instance of its occurrence in Canterbury.

Sixth Meeting: *6th November, 1895.*

Professor Dendy, D.Sc., President, in the chair.

*New Members.*—D. Bone, W. Binns, D. B. McLaren.

*Papers.*—1. "On the *Simulidæ* of New Zealand," by P. Marshall, M.A. (*Transactions*, p. 310.)

2. "On the Dicraniums of New Zealand," by R. Brown.

3. "A Comparison of the Magnetic Screening produced by Different Metals," by J. A. Erskine, M.A. (*Transactions*, p. 178.)

## ANNUAL MEETING: *18th April, 1896.*

Professor Arthur Dendy, D.Sc., in the chair.

### ABSTRACT OF ANNUAL REPORT.

During the session seven ordinary meetings have been held, at which nineteen papers were read. In addition, two popular scientific lectures were delivered by Captain Hutton and Professor Dendy. The number of members is the same as last year—viz., sixty-five—and the number of associates is seventy-nine. The photographic section is in a flourishing condition, and held a successful exhibition of photographs during the year.

The balance-sheet shows the total receipts to have been £69, and the expenditure £85 18s. 6d. This, with £41 10s. 11d. brought forward from last year, leaves the institute with a credit balance of £24 12s. 5d.

It is proposed, during the ensuing year, to make the ordinary meetings more interesting by microscopical exhibitions and short addresses.

The report of the photographic section was read and adopted.

ELECTION OF OFFICERS FOR 1896.—*President*—Professor Arthur Dendy, D.Sc.; *Vice-presidents*—Dr. W. Thomas, Dr. W. P. Evans; *Hon. Secretary*—R. Speight; *Hon. Treasurer*—Captain F. W. Hutton, F.R.S.; *Council*—H. R. Webb, R. M. Laing, S. Page, P. Marshall, F. C. Binns, and Dr. W. H. Symes.

Captain Hutton exhibited a female katipo, with nests and young. The young spider differs very much from the adult, the abdomen being white, with four longitudinal rows of black spots, the rest of the animal yellow-brown with dark bands on the legs. The nest is a spherical bag of pale-yellowish silk, rather less than ½in. in diameter.

Mr. Cockayne, who collected these animals at New Brighton, said that one of the adults squirted a sticky fluid out of its spinnerets at another individual, and so captured it.

Mr. Laing said that he had found katipos in sand-hills more than a mile from the sea.

The President delivered an address on "The Holothurians of New Zealand."

# OTAGO INSTITUTE.

First Meeting: *14th May, 1895.*

Mr. A. Hamilton, President, in the chair.

*New Members.*—Dr. R. Stuart Stephenson, Miss Browning, W. A. Sim, J. McLeod.

The President announced that, owing to the resignations of Dr. Chilton and the Rev. Dr. Belcher, the following alterations had been made in the *personnel* of the Council: *President*—A. Hamilton; *Vice-president*—Professor Scott; *Ordinary members*—A. Wilson and J. R. Don.

The President read a paper on "The Forests of New Zealand." (*Transactions*, p. 147.)

A discussion ensued, in which Messrs. A. Bathgate, G. M. Thomson, T. M. Hocken, and E. Melland took part: the President replied.

Mr. F. R. Chapman exhibited a specimen of the New Zealand passion-flower in fruit.

The President laid on the table, for the use of members, a number of copies of the catalogue of the library.

Second Meeting: *11th June, 1895.*

Mr. A. Hamilton, President, in the chair.

Mr. A. Wilson exhibited and made remarks upon an egg of *Megapodius pritchardi*, and upon a nest, probably of the hedge-sparrow, in which had been built a nest, apparently of a native wren, which in its turn had been used as a dwelling by humble-bees.

Professor Scott gave a demonstration of a method of colour-mixing by means of a modification of Maxwell's discs.

*Papers.*—1. Dr. Hocken read a paper on "The Etymology of the Word 'Penguin,'" producing historical evidence of the derivation of the word from the Celtic *pen* (head) and *gwen* (white).

The President and Mr. A. Wilson brought forward an earlier instance of the use of the word than that adduced by Dr. Hocken, and both they and Mr. F. R. Chapman considered that the question could not be considered as finally settled.

2. The President read a paper on "An Incident in the Early History of Otago." (*Transactions*, p. 141.)

Dr. Hocken, Mr. F. R. Chapman, and Mr. A. Wilson took part in the discussion on the paper. Mr. Chapman expressed the opinion that the burning of the village probably took place at some place south of Taiaroa Head.

THIRD MEETING: *9th July, 1895.*

Mr. A. Hamilton, President, in the chair.

Professor Parker gave a lecture entitled "Natural-History Notes of a Trip in the 'Hinemoa.'" The lecture was illustrated by a large collection of specimens from the islands visited.

There was a brief discussion.

FOURTH MEETING: *13th August, 1895.*

Mr. A. Hamilton, President, in the chair.

*New Member.*—Horatio A. Massey.

Mr. J. Tennant brought before the notice of the Institute a MS. catalogue, shortly to be printed, of the indigenous flowering-plants found within a radius of twenty-five miles of Dunedin. The catalogue had been prepared by the members of the Naturalists' Field Club, and was founded upon a similar list prepared and printed several years ago by the former Field Club.

In the ensuing discussion it was suggested that the area included in the operations of the club should be carefully defined, and that a radius of twenty-five miles was probably too wide.

*Papers.*—1. Dr. W. S. Roberts read a paper on "The Antitoxin Treatment of Diphtheria," prefaced by an exposition of the general methods of practical bacteriology, and illustrated by plate- and tube-cultures, and by microscopic slides.

2. Professor Parker read a paper on "Professor Huxley, from the Point of View of a Disciple."

FIFTH MEETING: *10th September, 1895.*

Mr. A. Hamilton, President, in the chair.

*New Members.*—George Fenwick and Thomas Hunter.

*Paper.*—Dr. Hocken read a paper on "Tasman's Journal." (*Transactions*, p. 117.)

SIXTH MEETING: *8th October, 1895.*

Mr. A. Hamilton, President, in the chair.

The Secretary gave an account of the steps which had been taken to establish a national memorial to the late Right Hon. T. H. Huxley, and stated that a local committee had been formed to promote the objects of the undertaking.

*Papers.*—1. The Secretary read extracts from a letter addressed to him by Dr. R. W. Shufeldt, of the Smithsonian Institution, Washington, "On the Affinities of *Harpagornis.*" (*Transactions*, p. 665.)

2. The Secretary read a paper by Mr. D. Petrie entitled "List of the Flowering-plants indigenous to Otago." (*Transactions*, p. 540.)

3. The Secretary exhibited and made remarks upon an arrow-worm (*Spadella*), from New Zealand waters. The pelagic group of worms, *Chætognatha*, comprising the two genera *Sagitta* and *Spadella*, is widely distributed, but hitherto does not seem to have been recorded in the Transactions as from the seas about New Zealand. The specimens referred to were taken in the tow-net off Antipodes Island, and in the plankton-net in Paterson's Inlet, Stewart Island, and in Norman's Inlet, Auckland Islands. They are closely allied to if not identical with *Spadella hamata*, Möbius.

4. Mr. G. M. Thomson read a paper on "New Zealand Fisheries, and the Desirability of introducing New Species of Fish."

5. The President read a paper on "Notes on a Branching Tree-fern." (*Transactions*, p. 622.)

ANNUAL MEETING: *12th November, 1895.*

Mr. A. Hamilton, President, in the chair.

ABSTRACT OF ANNUAL REPORT.

During the session six general meetings and seven meetings of Council have been held.

Eleven papers have been read, besides one lecture, and several exhibits and demonstrations.

Seven new members have joined the Institute, bringing the total membership to 107.

Early in the year Dr. Chilton, elected President at the last annual meeting, left the colony for England, and the Council was reluctantly obliged to accept his resignation, as also that of the Rev. Dr. Belcher, one of the members of Council. In accordance with the regulations the Council proceeded to fill the vacancies thus caused, and elected Mr. A. Hamilton as President, Professor Scott as one of the Vice-Presidents, and Messrs. A. Wilson and J. R. Don as ordinary members of Council.

A resolution has been adopted granting the privileges of life membership to all life members of societies affiliated to the New Zealand Institute who may come to reside in Dunedin, such members to obtain the annual volume of Transactions from the societies of which they were originally life-members. The resolution was communicated to the affiliated societies, with a request for reciprocal action, and several favourable replies have been received.

The Council has heard with great satisfaction that arrangements have been made by the Government for the publication of a new "Flora of New Zealand," under the editorship of Mr. T. W. Kirk, F.L.S.

The Council has nominated Mr. William Mitten, of Hurstpierpoint, Sussex, as an honorary member of the New Zealand Institute, and has again nominated Mr. James McKerrow to vote in the election of Governors.

The Council has voted a sum of money towards the systematic examination of the Otago Harbour and the neighbouring bays, with the view of furthering the establishment of a fish-hatching station.

The balance-sheet shows the total receipts of the year to be £87 2s. 6d., making, with the balance from last year, £111 15s. 9d. The expenditure for the year is £81 10s. 5d., leaving a credit balance of £30 4s. 10d.

Election of Officers for 1896.—*President*—A. Hamilton; *Vice-presidents*—G. M. Thomson, F.L.S., J. S. Tennant, B.Sc.; *Hon. Secretary*—Professor Parker, F.R.S.; *Hon. Treasurer*—J. R. Don, M.A.; *Other members of Council*—F. R. Chapman, T. M. Hocken, F.L.S., A. Bathgate, E. Melland, Professor Scott, M.D., A. Wilson, M.A., J. McLeod; *Hon. Auditor*—D. Brent, M.A

The President delivered an address on "The Rise and Progress of our Knowledge of the Oceanic Areas and their Zoology." (*Transactions*, p. 163.)

The following resolution was carried unanimously: "That this Institute desires to offer its sincere congratulations to Dr. John Murray on the completion of the 'Challenger' Reports, an event of the first scientific importance with which his name will always be honourably and gratefully associated."

# HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *13th May, 1895.*

The President, J. W. Carlile, M.A., in the chair.

The President read an address "On several Matters of Interest arising out of the Progress of Science during the Past Year, with Notices of the Chief Men of Science deceased during that Period."

Second Meeting: *10th June, 1895.*

The President in the chair.

*Papers.*—1. "The Zoda or Thodawar Tribe of Madras, and their Funeral Customs," by A. R. W. Lascelles.

2. "Bimetallism," by W. F. Howlett.

3. "A Census of the Slips which occurred in this District during the Rainy Season of 1894," by H. Hill, B.A., F.G.S. (*Transactions*, p. 666.)

Third Meeting: *15th July, 1895.*

The Vice-president, H. H. Pinckney, B.A., in the chair.

*Papers.*—1. "Reminiscences of the Tin-mines of Cornwall Seventy Years ago," by Rev. W. Colenso, F.R.S., F.L.S.

2. "The Coinage of England under Charles I.," by H. M. Lund.

3. "Ruapehu," by H. Hill, B.A., F.G.S. (*Transactions*, p. 681.)

Fourth Meeting: *12th August, 1895.*

The Vice-president in the chair.

*Papers.*—1. "Bird-life on a Run," by H. Guthrie-Smith. (*Transactions*, p. 367.)

2. "Native Names of Places," by Taylor White.

3. "The Ceremony of Rahui," by Taylor White. (*Transactions*, p. 54.)

FIFTH MEETING: *9th September, 1895.*

Mr. J. W. Craig in the chair.

Mr. H. Hill, B.A., F.G.S., gave an address on "University Extension in New Zealand."

SIXTH MEETING: *21st October, 1895.*

The Vice-president in the chair.

*Papers.*—1. "Pond Spiders," by Taylor White.

2. "A Hunting Spider," by Taylor White.

3. "Rats Nesting in Trees," by Taylor White.

4. "The Moa and the Maoris," by Taylor White.

5. "Description of Three New Ferns," by Rev. W. Colenso, F.R.S. (*Transactions*, p. 618.)

6. "New Zealand Cryptogams," by Rev. W. Colenso, F.R.S. (*Transactions*, p. 615.)

7. "New Zealand Phænogams," by Rev. W. Colenso, F.R.S. (*Transactions*, p. 591).

The Rev. W. Colenso, F.R.S., F.L.S., gave an interesting address on "Antarctic Exploration," narrating his recollections of the Ross expedition, only one member of which (Sir J. D. Hooker, F.R.S.) still survives.

ANNUAL MEETING: *9th March, 1896.*

ABSTRACT OF ANNUAL REPORT.

Six ordinary meetings were held, and were well attended. The number of papers read was seventeen. The Council regret a further decrease in the membership, which now stands at eighty. Twelve volumes have been added to the library. The Council has heard with regret of the death of Mr. F. H. Meinertzhagen, who was for many years an energetic member of the Institute, and a generous benefactor of the library. The Council also regret that since the termination of the year the Institute has lost an old and valued member in the person of Mr. H. S. Tiffen.

The balance-sheet showed a total receipt of £87 8s. 9d., including £9 balance from previous year; while the expenditure was £84 15s. 9d., leaving a balance in hand of £2 13s.

ELECTION OF OFFICERS FOR 1896.—*President*—Rev. W. Colenso, F.R.S., F.L.S., &c.; *Vice-president*—T. C. Moore, M.D.; *Council*—J. W. Craig, H. Hill, B.A., F.G.S., T. Humphries, J. S. Large, Dr. Milne-Thomson, T. Whitelaw; *Hon. Secretary*—W. Dinwiddie; *Hon. Treasurer*—G. White; *Auditor*—J. Crerar.

# NELSON PHILOSOPHICAL SOCIETY.

First Meeting: *16th September, 1895.*

The Bishop of Nelson, President, in the chair.

Dr. J. Hudson read extracts from an article upon "The Anti-toxin Treatment of Diphtheria."

*Exhibits.*—(1.) Specimens of *Hymenophyllum montanum* and *Lindsaya viridis*, from Blind Bay, by Mr. R. I. Kingsley. (2.) Specimen of bass (?), caught at Motueka, by Mr. Moffat. (3.) Star-fish, by the Curator. (4.) Fruit-bat, from Mauritius. (5.) Black New Zealand rat, caught in Nelson. (6.) Australian roller (*Eurystomus pacificus*), from Nelson. (7.) *Planchonia quercicola*, scale-blight new to New Zealand, discovered at Stoke by R. I. Kingsley. (8.) Portions of moa-bones, found on papa rock at Sherry. (9.) Crystallized quartz, from Mr. Hodges.

Annual Meeting: *13th January, 1896.*

The Bishop of Nelson, President, in the chair.

Abstract of Annual Report.

The report stated that, although few meetings were held, interesting facts and valuable information had been collected during the year.

The balance-sheet showed a total receipt of £29 11s. 11d., inclusive of £11 15s. 2d. brought forward from the previous year; while the expenditure was £15 4s. 3d., and the balance in hand £14 7s. 8d.

Election of Officers for 1896.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson, F.L.S., and Dr. W. J. Mackie; *Council*—Dr. L. Boor, Messrs. E. Lukins, W. F. Worley, J. G. Bartell, and J. Holloway; *Hon. Secretary*—R. I. Kingsley; *Treasurer*—Dr. J. Hudson; *Curator*—R. I. Kingsley; *Assistant Curator*—E. Lukins.

*Papers.*—1. "Remarks on the Government of the New Zealand Institute," by A. S. Atkinson, F.L.S.

2. "Zoological Notes," by R. I. Kingsley. (*Transactions*, 449.)

3. "Botanical Notes," by R. I. Kingsley. (*Transactions*, p. 537.)

*Exhibits.*—(1.) A large collection of New Zealand insects, collected by Mr. John Thomas, of Waimea West (now ninety-eight years of age). (2.) Stuffed specimen of *Rattus philippensis*, by Mr. J. F. Kitching. (3.) Four marine shells, from Mauritius, by Mr. A. H. Patterson. (4.) Stuffed specimen of Cape-pigeon, by Mr. Martin. (5.) One hundred facsimile casts of stone implements of North American Indians. (6.) Set of twelve volumes of publications of Bureau of Ethnology of United States: the two latter presented by the Smithsonian Institution, Washington. (7.) Pair of young emus, hatched in Nelson (purchased).

# APPENDIX

# METEOROLOGY.

## Comparative Abstract for 1895 and Previous Years.

| Stations. | Barometer at 9.30 a.m. | | Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously. | | | | | Computed from Observations. | | Rain. | | Wind. | | Cloud. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Reading. | Extreme Range. | Mean. Temp. in Shade. | Mean Daily Range of Temp. | Extreme Range of Temp. | Max. Temp. in Sun's Rays. | Min. Temp. on Grass. | Mean Elastic Force of Vapour. | Mean Degree of Moisture (Saturation = 100). | Total Fall in Inches. | No. of Days on which Rain fell. | Average Daily Force in Miles for Year. | Maximum Velocity in Miles in any 24 hours, and Date. | Mean Amount (0 to 10). |
| Auckland... ... ... | 30·097 | 1·150 | 58·5 | 12·2 | 46·0 | 145·0 | 32·0 | 0·368 | 73 | 44·150 | 204 | ... | ... | 5·3 |
| Previous 31 years ... | 29·991 | ... | 59·2 | ... | ... | ... | ... | 0·386 | 73 | 42·147 | 182 | ... | ... | ... |
| Wellington ... ... | 29·965 | 1·234 | 55·1 | 12·1 | 56·0 | 145·0 | 20·0 | 0·321 | 72 | 61·473 | 165 | 316 | 700 on 9th March. | 4·7 |
| Previous 31 years ... | 29·930 | ... | 54·8 | ... | ... | ... | ... | 0·335 | 73 | 50·804 | 159 | ... | | ... |
| Dunedin ... ... ... | 29·829 | 1·548 | 50·3 | 14·2 | 66·0 | 150·0 | 23·0 | 0·273 | 74 | 51·396 | 177 | 154 | 560 on 10th Oct. | 5·6 |
| Previous 31 years ... | 29·977 | ... | 50·2 | ... | ... | ... | ... | 0·277 | 73 | 36·398 | 158 | ... | | ... |

## Average Temperature of Seasons, compared with those of the Previous Year.

| Stations. | Spring. September, October, November. | | Summer. December, January, February. | | Autumn. March, April, May. | | Winter. June, July, August. | |
|---|---|---|---|---|---|---|---|---|
| | 1894. | 1895. | 1894. | 1895. | 1894. | 1895. | 1894. | 1895. |
| Auckland ... ... ... | 57·8 | 56·3 | 67·8 | 67·1 | 60·3 | 59·9 | 53·1 | 50·6 |
| Wellington ... ... ... | 54·6 | 54·2 | 64·1 | 63·9 | 57·3 | 55·2 | 49·6 | 47·1 |
| Dunedin ... ... ... | 50·8 | 49·9 | 59·5 | 59·4 | 50·7 | 49·7 | 43·3 | 41·5 |

## REMARKS ON THE WEATHER DURING 1895.

JANUARY.—Showery in early part of month in North and over centre, but fine latter part, with N.E. and N.W. winds. Fine weather in South.

FEBRUARY.—Fine weather in North; a wet month over centre; and heavy rain in South in early and latter part of month.

MARCH.—Fine weather generally, except heavy rain in South, chiefly from S.W.

APRIL.—Fine in North; over centre heavy rain in middle of month, causing floods; wind S.E. In South changeable and unpleasant weather, with strong winds and fogs.

MAY.—An excess of rain throughout, and unpleasant weather; and heavy snowfall in South.

JUNE.—Very heavy rainfall generally, with strong N.W. and S.W. winds; fogs and hail over centre; and snow in South.

JULY.—Heavy rain generally, with storms from S.W. in North, and frequent hail and fog; and severe snowstorms in South.

AUGUST.—Fine weather, but showery over centre, with strong N.W. winds and frequent hail; rather finer in South.

SEPTEMBER.—Heavy rain in North and strong N.W. and S.W. winds and thunder; rather finer over centre, but with fresh N.W. winds and thunder; fine in South.

OCTOBER.—Generally showery, with intervals of fine weather and strong N.W. winds over centre.

NOVEMBER.—The rainfall this month over the average, and generally unpleasant weather.

DECEMBER.—A very fine pleasant month generally, although rather showery in South; strong N.W. winds over centre.

## EARTHQUAKES reported in NEW ZEALAND during 1895.

| PLACE. | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gisborne .. | .. | .. | .. | .. | .. | .. | .. | 17,* 21* | .. | .. | .. | .. | 2 |
| Napier .. | .. | .. | .. | .. | .. | .. | .. | 17,* 21* | .. | 11* | .. | .. | 3 |
| Taupo .. | .. | .. | .. | .. | .. | .. | .. | 17,* 21* | .. | .. | .. | .. | 2 |
| New Plymouth | .. | .. | .. | .. | .. | .. | .. | 24 | 29, 30 | 1, 2, 3,* 4,* 5, 12, 26* | 29* | 5* | 12 |
| Palmerston N. | .. | .. | .. | .. | .. | .. | .. | 17* | .. | .. | .. | .. | 1 |
| Feilding .. | .. | .. | .. | .. | .. | .. | .. | 17,* 21* | .. | .. | .. | .. | 2 |
| Masterton .. | .. | 26 | .. | .. | .. | .. | .. | 2* | .. | .. | .. | .. | 2 |
| Wellington .. | .. | 6, 26 | .. | 17 | 27 | 3, 20 | 17 | 17, 21 | 13 | .. | 9 | .. | 11 |
| Lincoln .. | .. | .. | .. | .. | .. | .. | .. | 5* | .. | .. | .. | .. | 1 |
| Greymouth .. | 12* | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Dunedin .. | .. | .. | .. | .. | .. | 8 | 27 | 4 | .. | .. | .. | .. | 3 |

NOTE.—The figures denote the day of the month on which one or more shocks were felt. Those with the asterisk affixed were described as *smart*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. These tables are therefore not reliable as far as indicating the geographical distribution of the shocks.

# NEW ZEALAND INSTITUTE.

## HONORARY MEMBERS.

### 1870.

FINSCH, OTTO, Ph.D., of Bremen
FLOWER, W. H., F.R.S., F.R.C.S.
HOOKER, Sir J. D., K.C.S.I., C.B., M.D., F.R.S.
VON MUELLER, Baron Sir FERDINAND, K.C.M.G., M.D., F.R.S.
RICHARDS, Admiral Sir G. H., C.B., F.R.S.

### 1872.

GREY, Sir GEORGE, K.C.B., P.C., D.C.L.

### 1873.

BOWEN, Sir GEORGE FERGUSON, G.C.M.G., P.C.
CAMBRIDGE, The Rev. O. PICKARD, M.A., C.M.Z.S.
GÜNTHER, A., M.D., M.A., Ph.D., F.R.S.

### 1874.

McLACHLAN, ROBERT, F.L.S.
NEWTON, ALFRED, F.R.S.

### 1875.

SCLATER, PHILIP LUTLEY, M.A., Ph.D., F.R.S.

### 1876.

ETHERIDGE, Prof. ROBERT, F.R.S.
BERGGREN, Dr. S.

### 1877.

SHARP, Dr. D.

### 1878.

MÜLLER, Professor MAX, F.R.S.

### 1883.

Lord KELVIN, P.R.S.
ELLERY, ROBERT L. J., F.R.S.

### 1885.

SHARP, RICHARD BOWDLER, M.A., F.L.S.
WALLACE, A. R., F.L.S.

### 1888

McCOY, Professor Sir F., K.C.M.G., Sc.D., F.R.S.
VON ETTINGSHAUSEN, Baron C.

### 1890.

NORDSTEDT, Professor OTTO, Ph.D.
LIVERSIDGE, Professor A., M.A., F.R.S.

### 1891.

GOODALE, Professor G. L., M.D., LL.D.
DAVIS, J. W., F.G.S., F.L.S.

### 1894.

DYER, Professor THISELTON-, M.A., C.M.G., F.R.S.
CODRINGTON, Rev. R. H., D.D.

### 1895.

MITTEN, WILLIAM, F.L.S.

## ORDINARY MEMBERS.

### WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life-members.]

Adams, Dr.
Allen, F.
Anson, Dr.
Atkinson, A. R.
Atkinson, A. S., Nelson
Baldwin, P. E.
Barnes, R. J.
Baron, J. Suckling
Barraud, W. F.
Barron, C. C. N.
Barton, W.
Batkin, C. T.
Beetham, G.
Beetham, W. M.
Bell, E. D.
Bell, H. D.
Best, E., Hadfield
Blair, J. R.
Bold, E. H., C.E., Napier
Bothamley, A. T.
Brandon, A. de B.
Brown, W. R. E.
Buchanan, John, F.L.S.*
Buller, Sir W. L., K.C.M.G., D.Sc., F.R.S.
Caldwell, R.
Campbell, J. P.
Chapman, Martin
Chapple, Dr.
Chudleigh, E. R.
Cohen, W. T.
Colenso, W., F.R.S., F.L.S., &c., Napier
Connal, E.
Davy, Dr. T. G., Kumara
Dawson, B.
Denton, George
Drew, S. H., Wanganui
Elliot, Major E. H. J.
Evans, W. P., M.A., Ph.D.
Ewart, Dr.
Farquhar, H.
Ferard, B. A., Napier
Ferguson, W., C.E.
Field, H. C., Wanganui
Fraser, F. H.
Freeman, H. J.
Gillespie, C. H.
Gordon, H., F.G.S.
Gore, R. B.
Grace, Hon. M. S., C.M.G., M.D.
Hadfield, E. F.
Hanify, H. P.
Harcourt, J. B.
Harding, R. Coupland
Hawthorne, E. F.
Haylock, A.
Hector, Sir James, K.C.M.G., M.D., F.R.S.
Henley, J. W.
Herbert, W. H.
Higginson, H. P., M.Inst.C.E.
Hislop, Hon. T.
Holmes, R. L., F.R. Met. Soc., Fiji*
Holmes, R. T., Masterton
Hudson, G. V., F.E.S.
Hughes, H., M.I.M.E.
Hulke, C., F.C.S.
Hustwick, T. H.
Inwood, D., Canterbury
Johnson, Hon. G. Randall*
Kenny, Hon. Captain C.
King, T.
Kirk, H. B., M.A.
Kirk, Thomas, F.L.S.
Kirk, T. W., F.L.S.
Kirk, W. L.
Krull, F. A., Wanganui

Lambert, T. S.
Lee, H. M.
Lee, R.
Liffiton, E. N., Wanganui
Litchfield, A. J., Blenheim
Logan, H. F.
Lomax, H. A., Wanganui
Mackenzie, F. Wallace, M.B.
Malcolm, Miss J.
Marchant, J. W. A.
Martin, Dr. A.
Maskell, W. M.
Mason, Thomas, Hutt
Maxwell, J. P., M.Inst.C.E.
McDougall, A.
McKay, Alexander, F.G.S.
McLeod, H. N.
McWilliam, Rev. W., Otaki
Mestayer, R. L., M.Inst.C.E.
Molineaux, B. M.
Morison, C. B.
Murdoch, R., Wanganui
Nairn, C. J., Hawke's Bay
Newman, Alfred K., M.B., M.R.C.P.
Ogg, Rev. C. S.
Orr, Robert
Park, R. G.*
Pearce, E.
Pharazyn, C., Wairarapa
Pharazyn, Hon. R., F.R.G.S.
Phillips, Coleman
Pierard, C. H.
Pollen, Hugh
Pollen, Dr.
Powles, C. P.
Poynton, J. W.
Prendergast, Sir J., Chief Justice
Reid, W. S.
Richardson, C. T.
Rowse, Rev. W., Greytown
Roy, R. B., New Plymouth
Rutherfurd, A. J.
Rutherfurd, W. G.
Samuel, E.
Schaw, Major-General, C.B., R.E.
Simcox, W. H., Otaki
Sinclair, J.
Skerman, Dr. Sydney, Marton
Skey, W.
Smith, C. O'Hara
Smith, Charles, Wanganui
Smith, S. Percy, F.R.G.S.
Stewart, J. T., Wanganui
Stowell, H. M.
Stuart, A. P.
Tait, P. W.
Tait, R.
Talbot, Dr. A. G.
Tanner, Cyril
Tod, Andrew, Wanganui
Travers, W. T. L., F.L.S.
Tregear, E.
Turnbull, A. H., London
Turnbull, R. T.
Turnbull, Thomas
Wallace, James
Waterhouse, G. M., F.R.G.S.
Wilton, G. W.
Woodhouse, Alfred James, London

## AUCKLAND INSTITUTE.

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H.



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L.

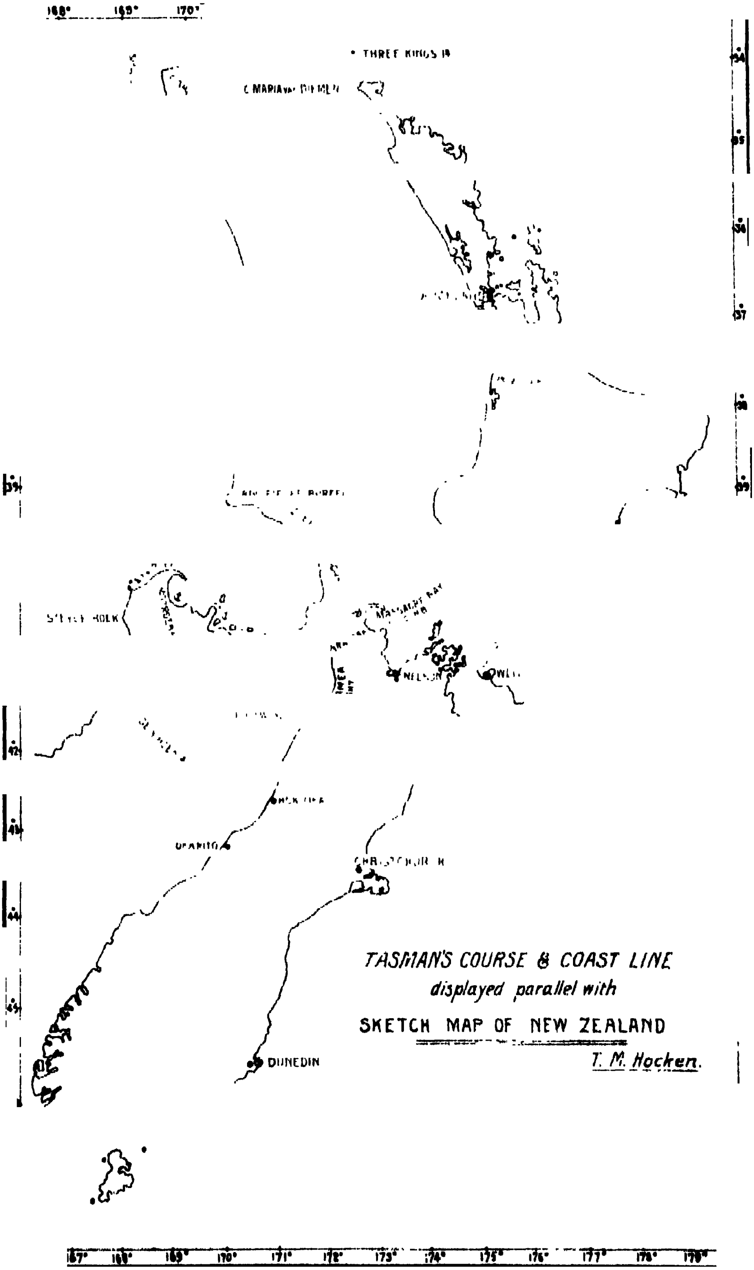


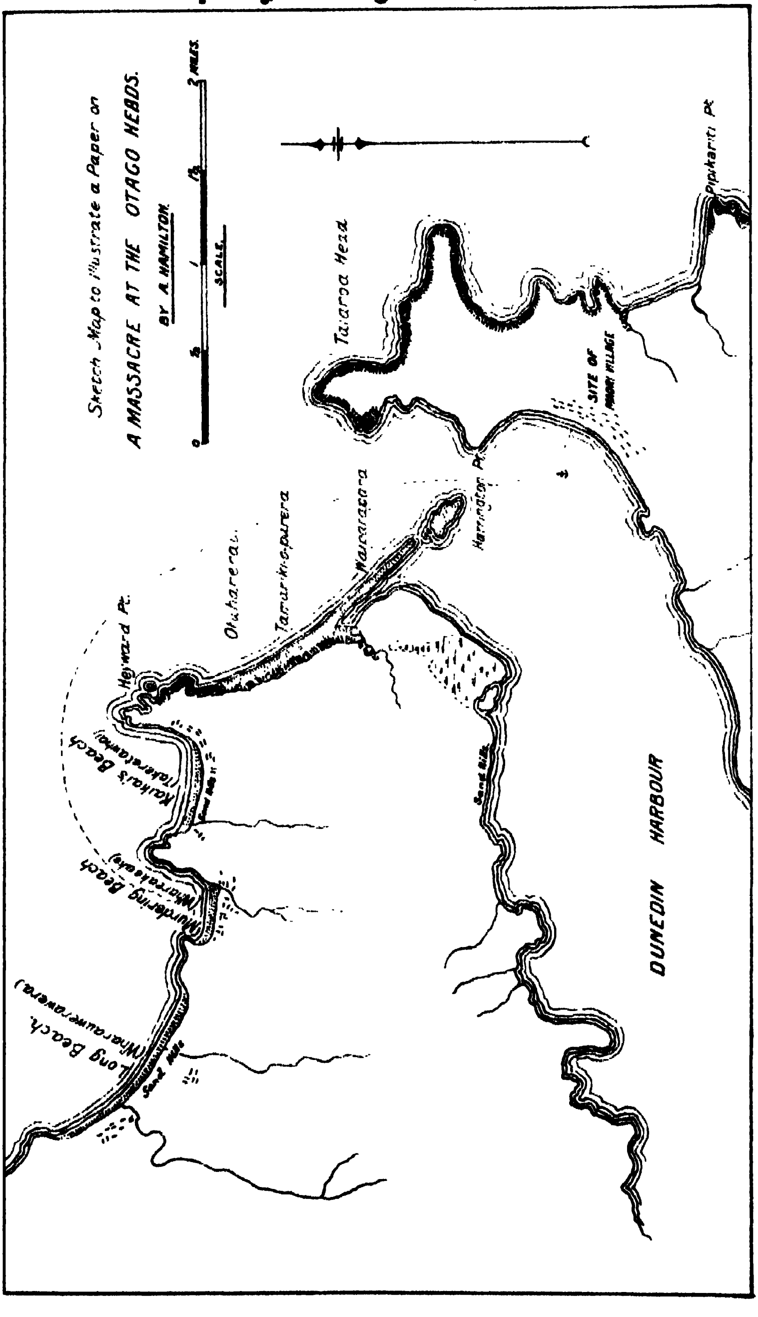
M.



N.

John Mackay, Government Printer, Wellington.—1896.


THREE KINGS
DUNEDIN
TASMAN'S COURSE & COAST LINE
displayed parallel with
SKETCH MAP OF NEW ZEALAND
T. M. Hocken.


Sketch Map to illustrate a Paper on
A MASSACRE AT THE OTAGO HEADS.
BY A. HAMILTON.
SCALE.
0 ½ 1 1½ 2 MILES
Taiaroa Head
Pipikariti Pt.
SITE OF MAORI VILLAGE
Heyward Pt.
Kaikai's Beach
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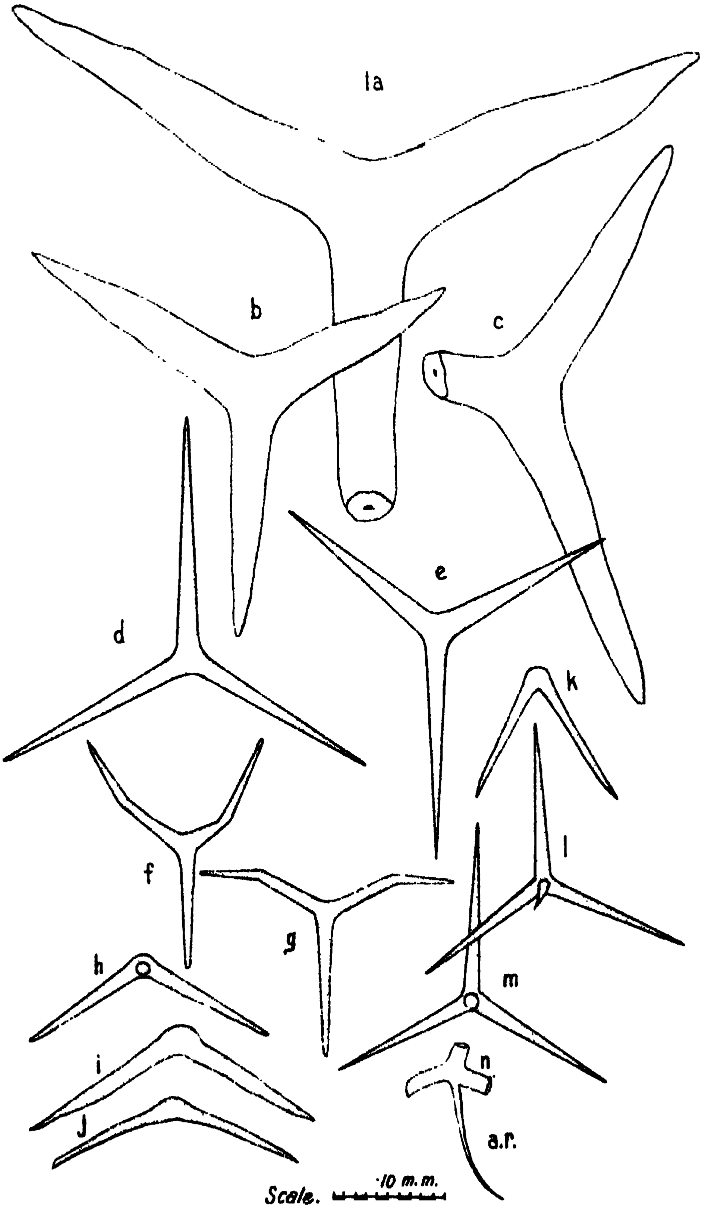
DUNEDIN HARBOUR

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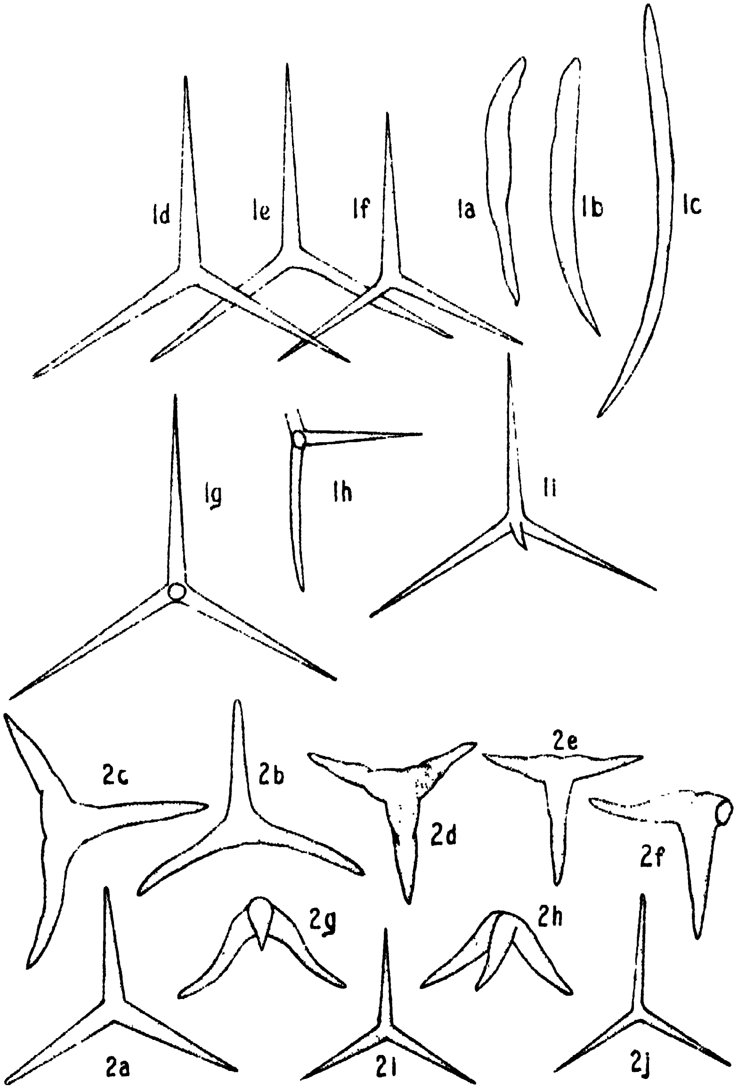


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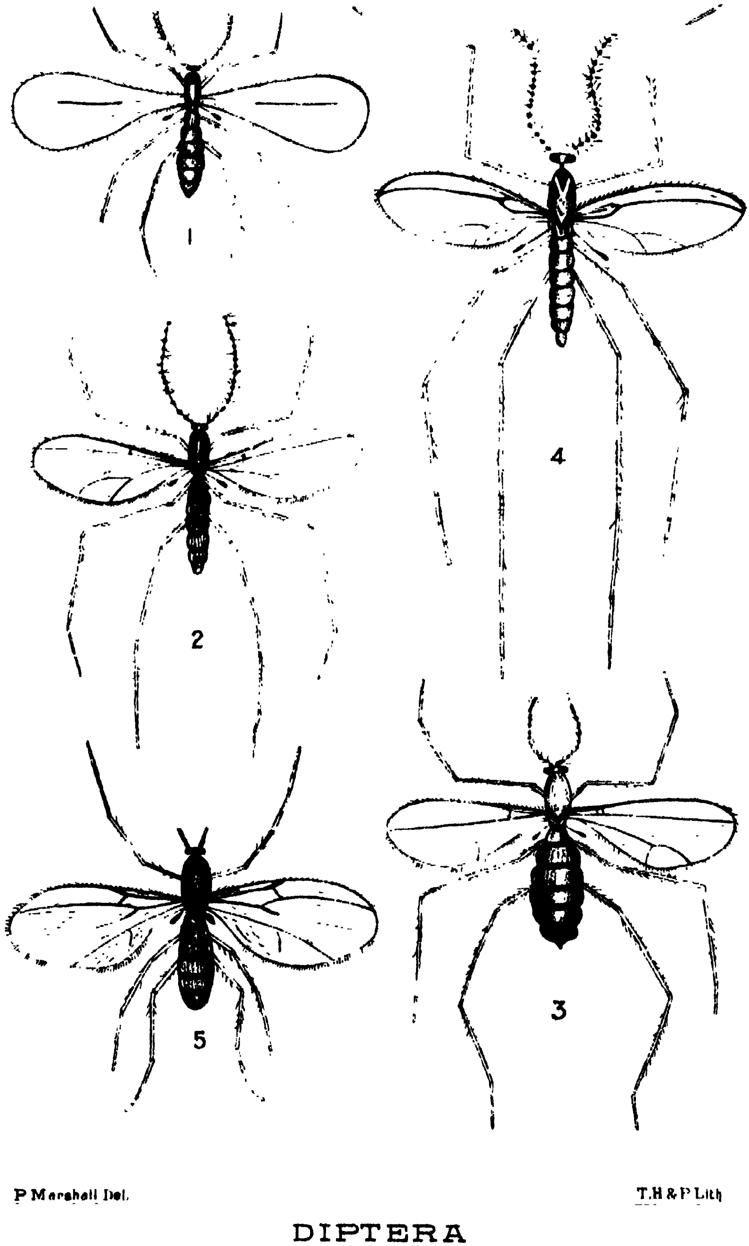
H B K Del Scale. T H & P Lith




P Marshall Del.

T.H & P Lith

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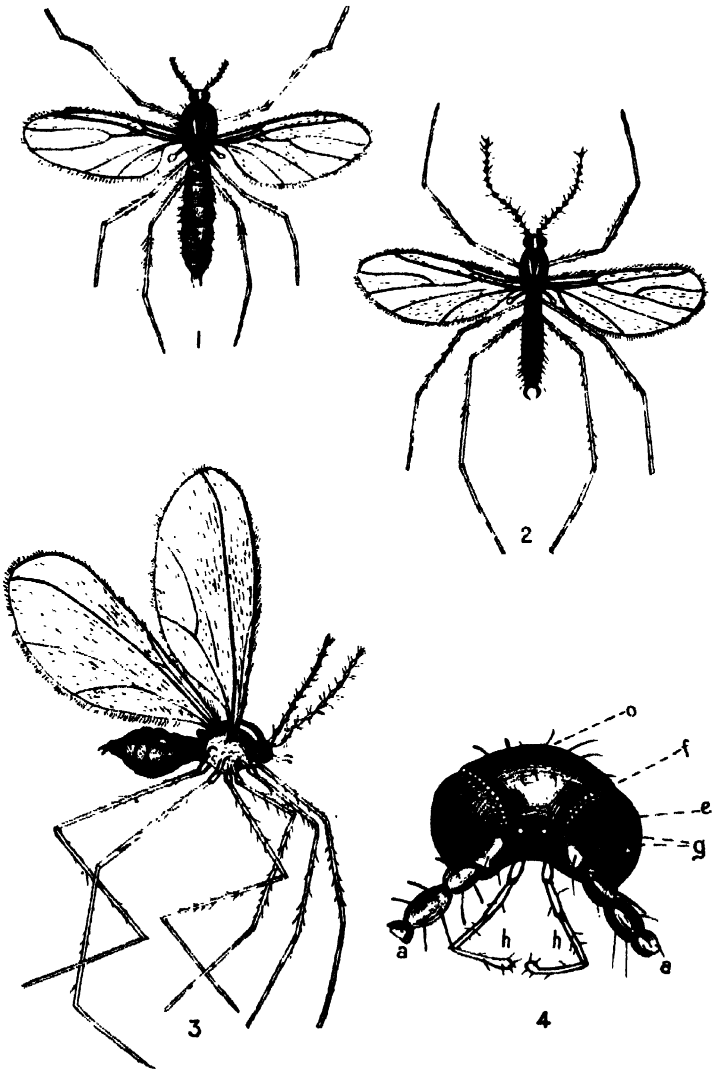


P Marshall, Del

T.H & P Lith.

DIPTERA

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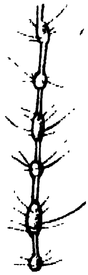

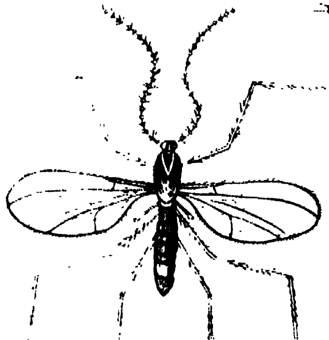

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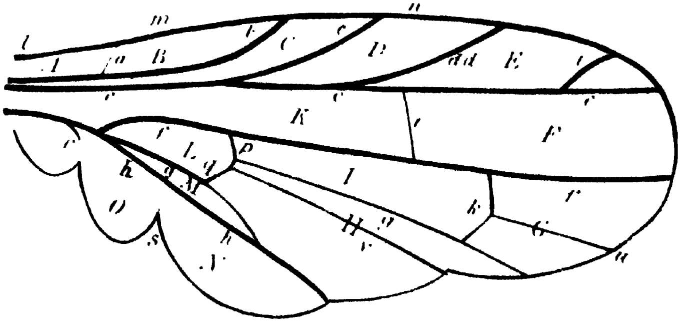

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T H & P Lith

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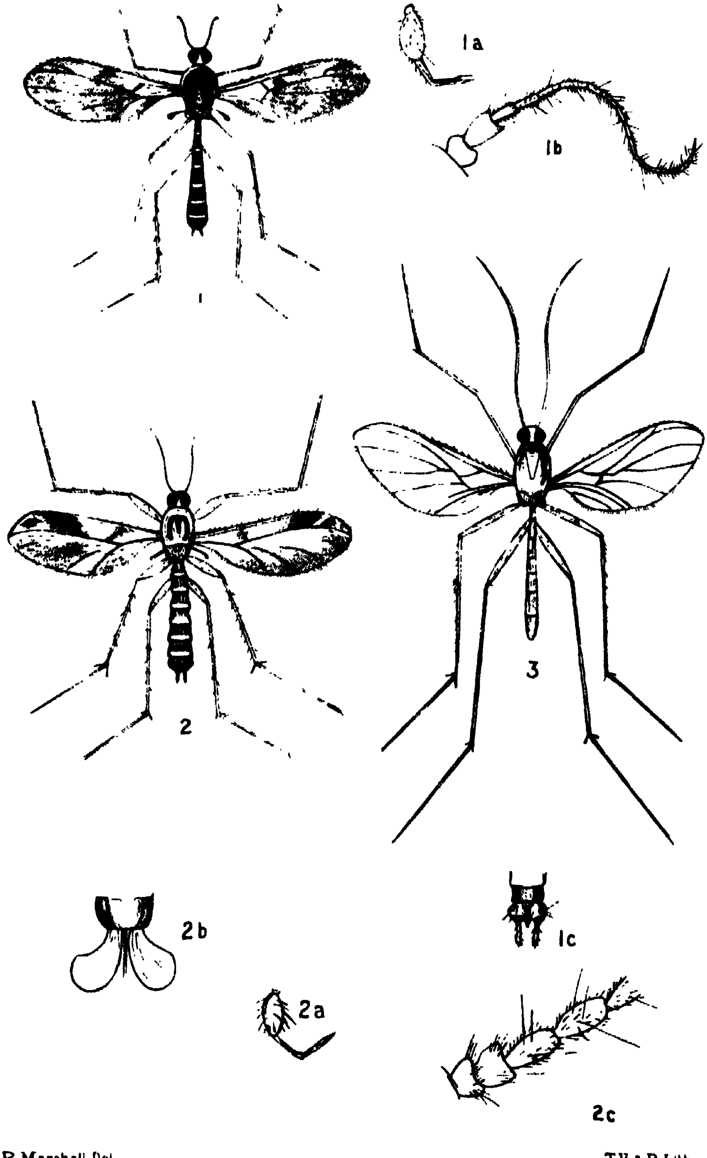


P. Marshall, Del.

T.H.&P. Lith.

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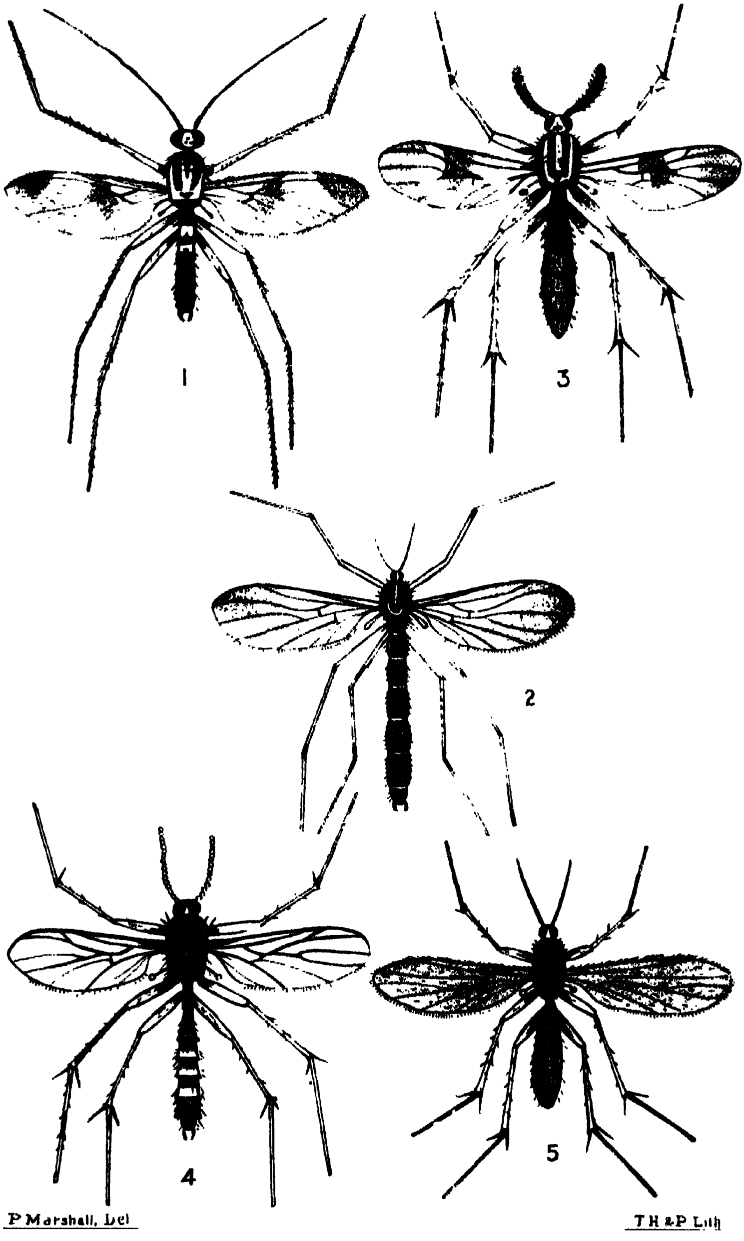


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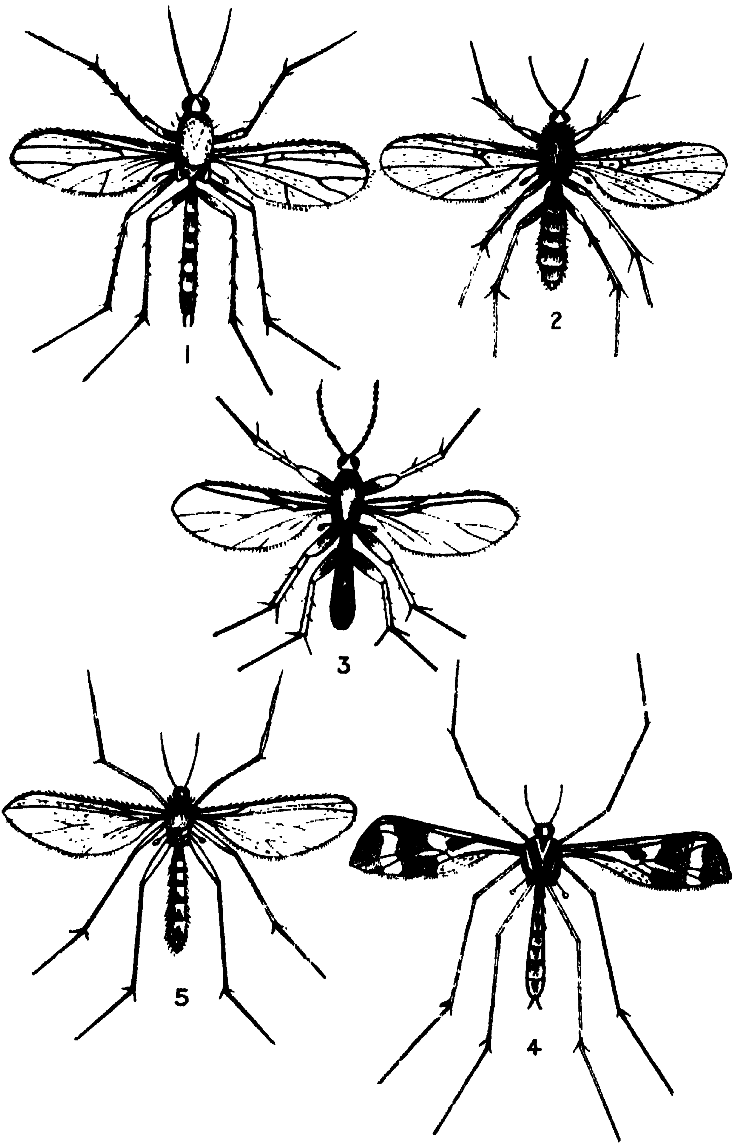


P. Marshall, Del

T H & P Lith

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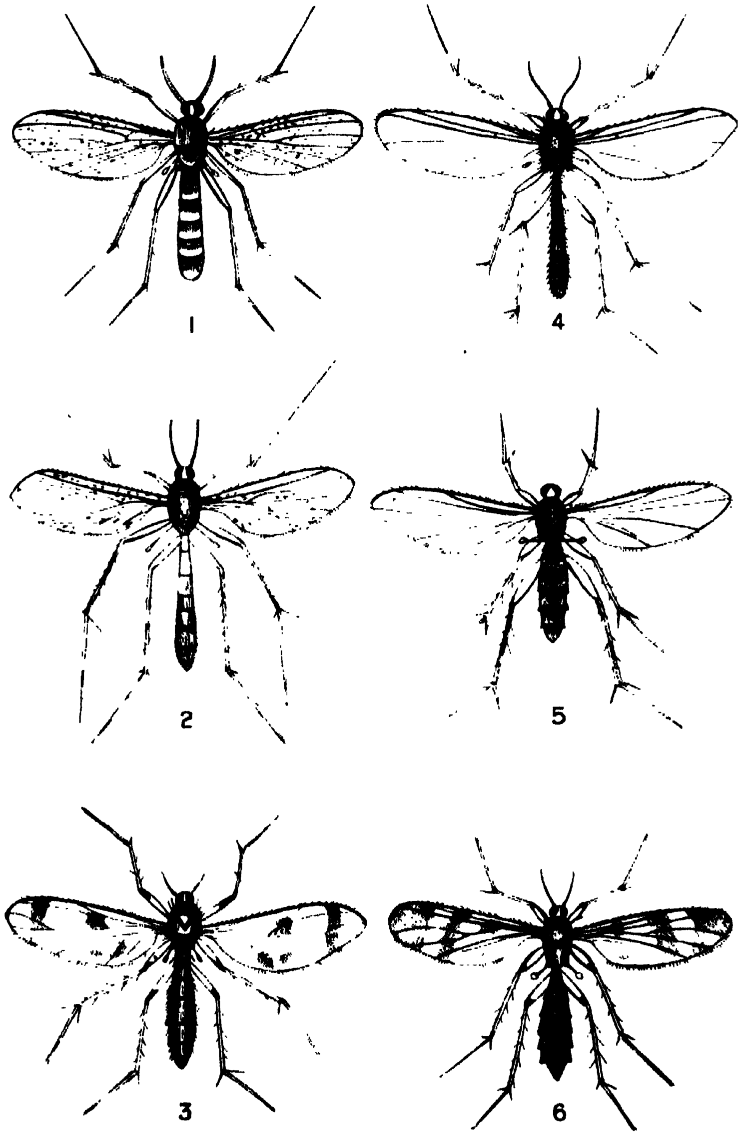


P Marshall Del

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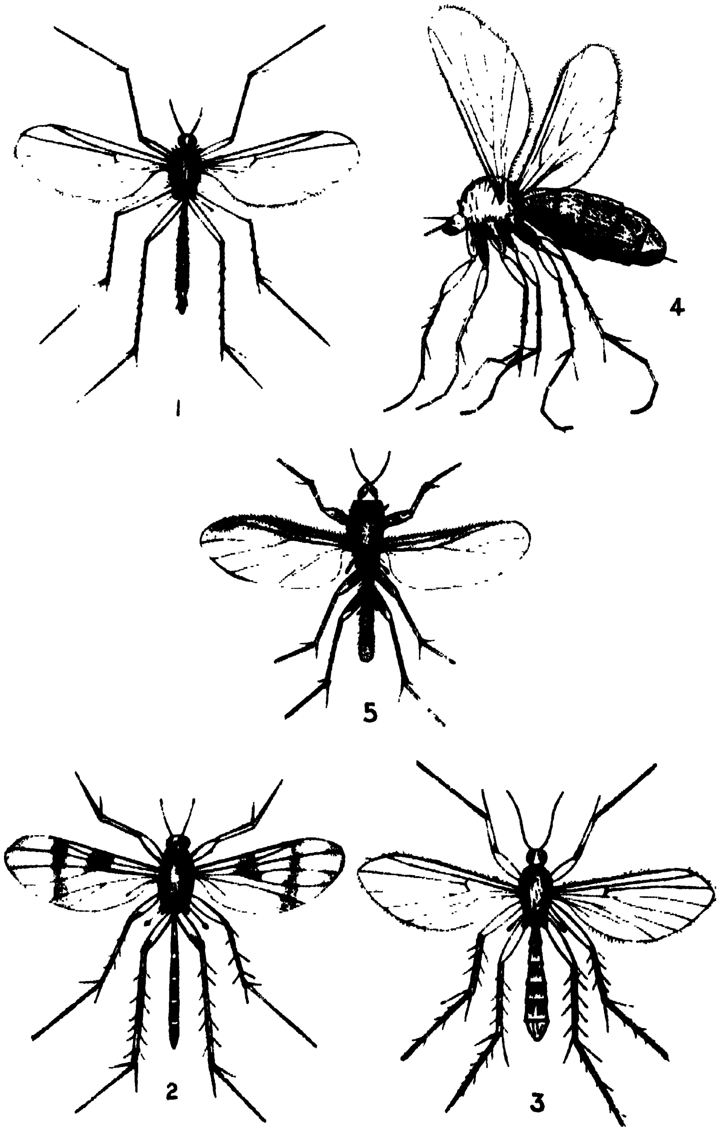


P Marshall Del

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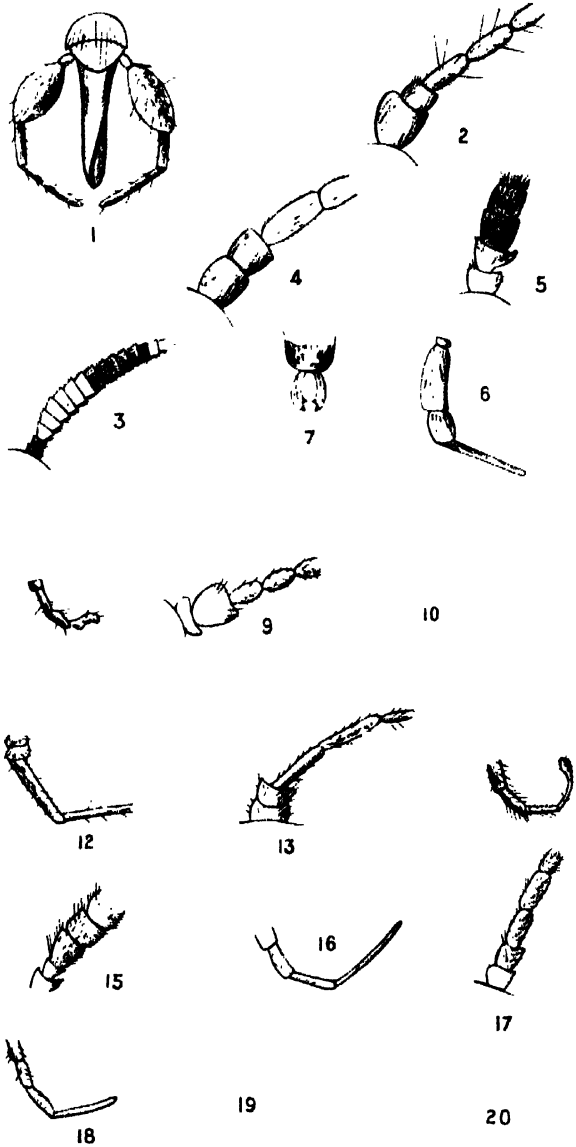


P. Marshall Del

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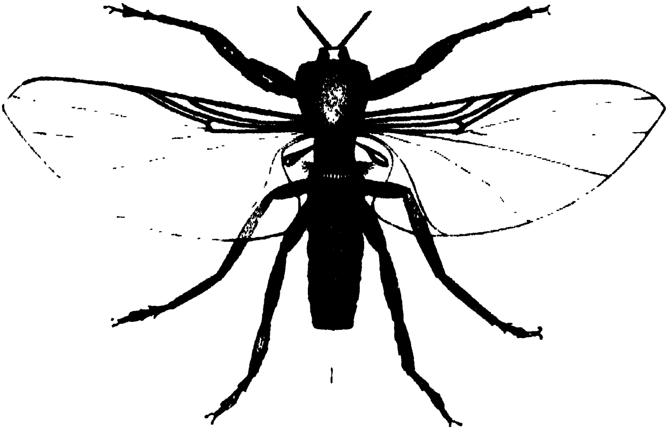

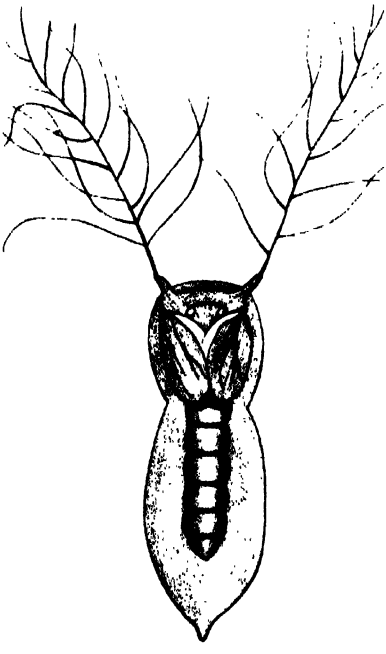

P Marshall, Del

T H & P. Lith

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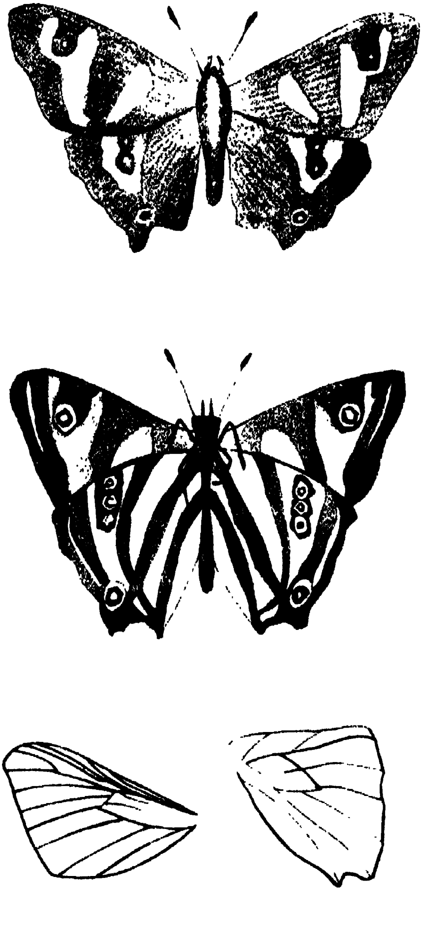

P Marshall, Del

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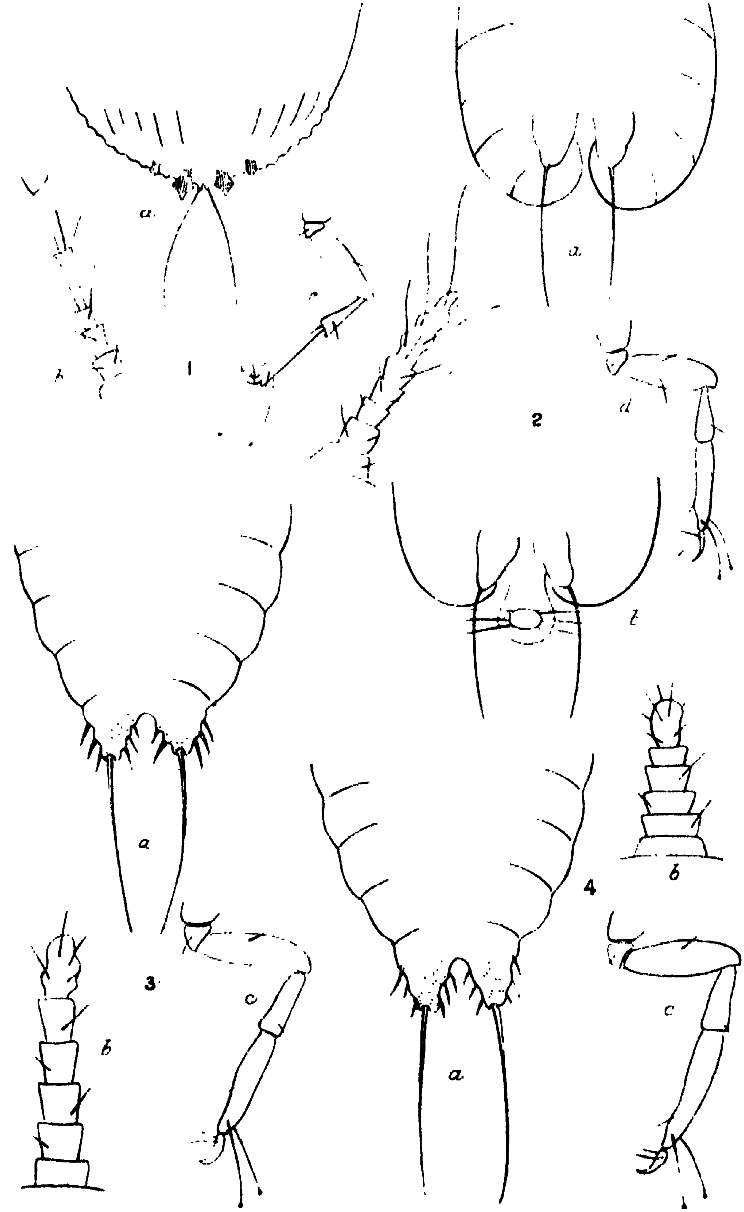


W. M M del ad nat

T H & P Lith

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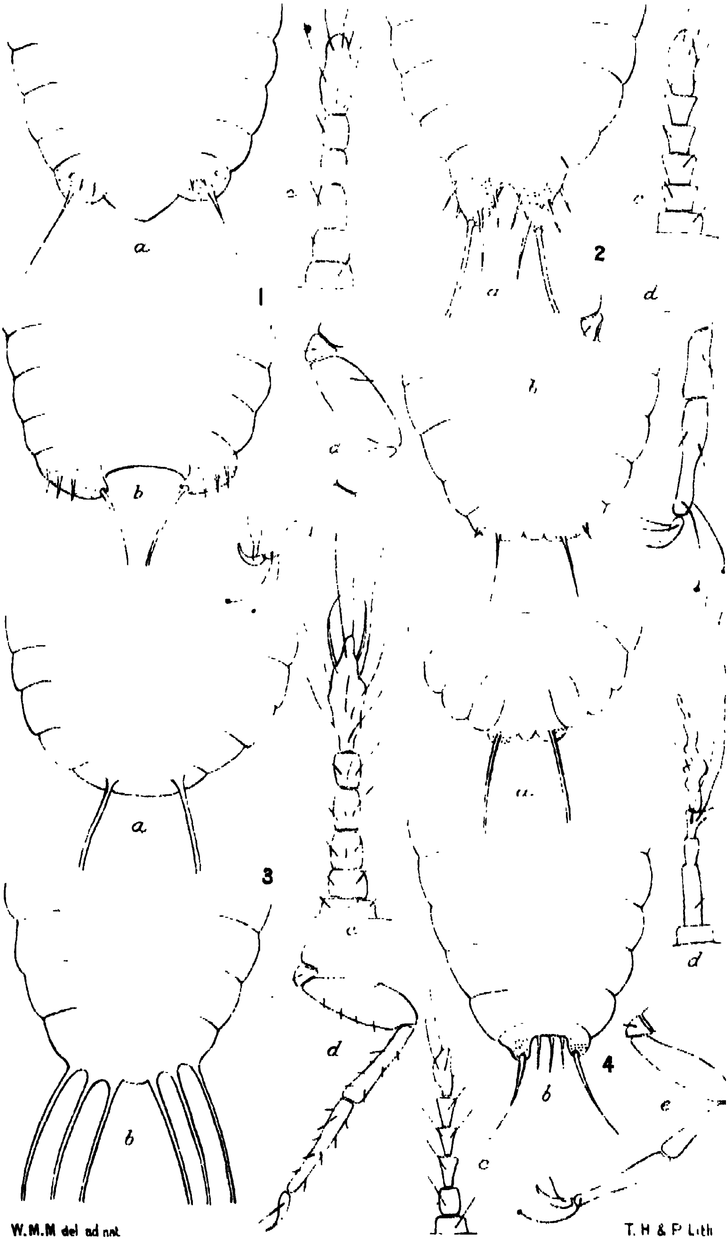


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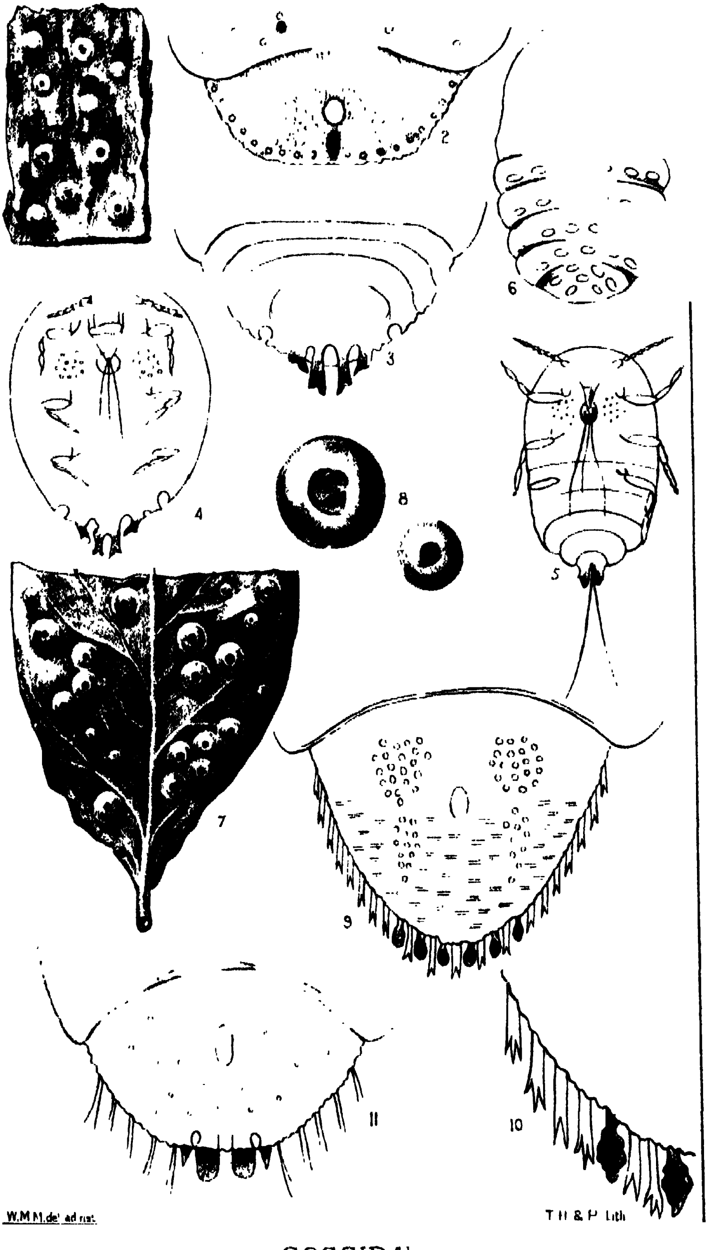


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T H & P Lith

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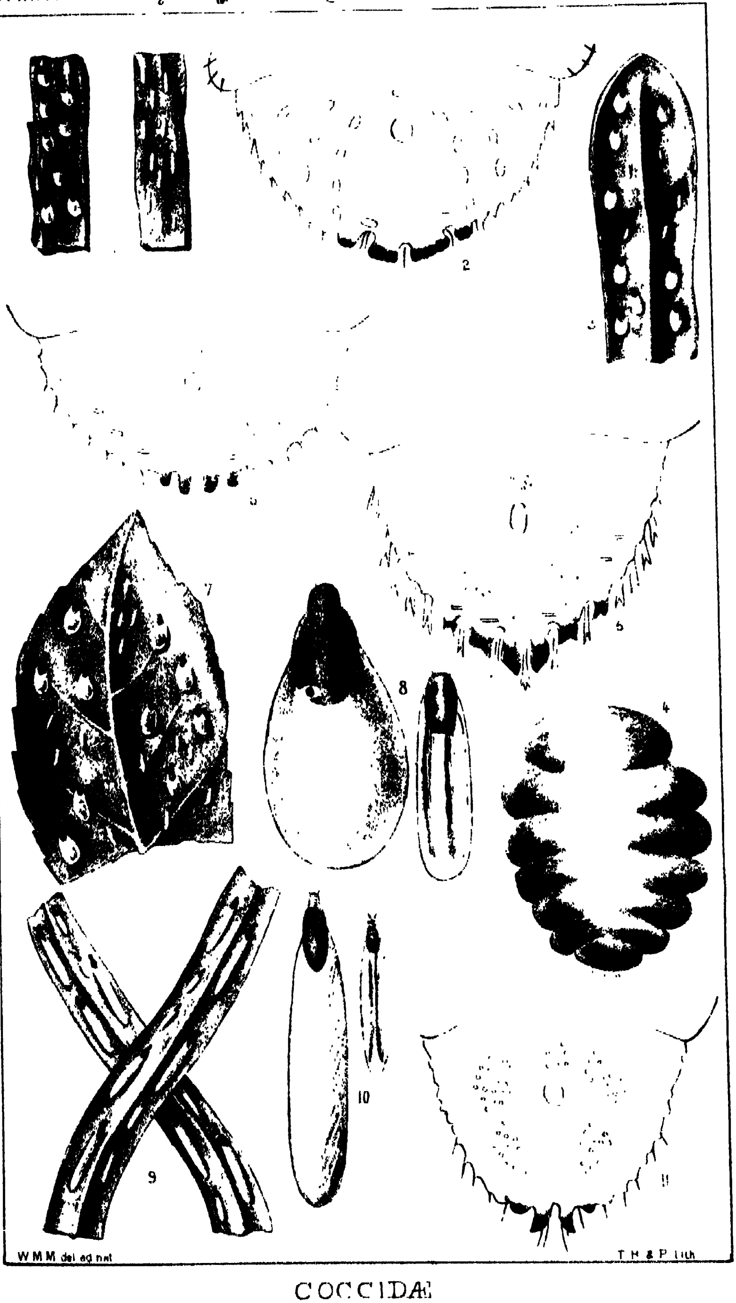


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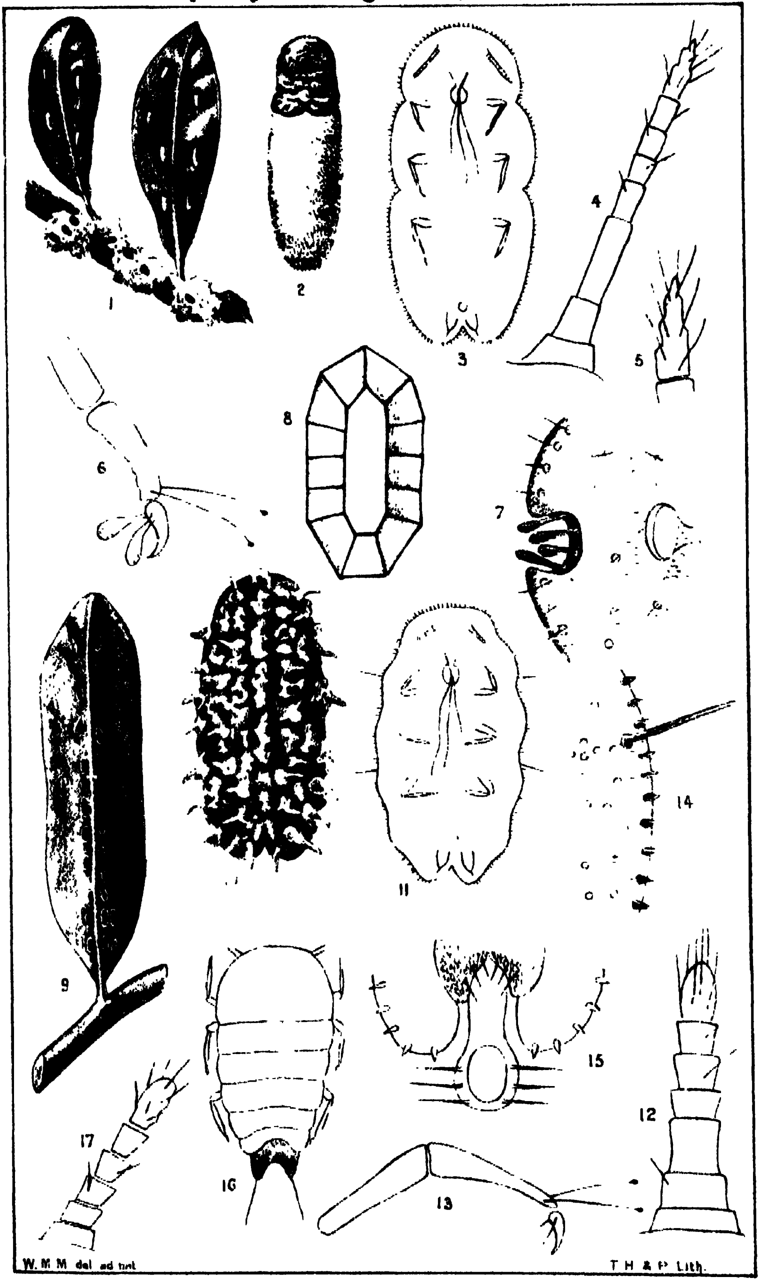


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T. H. & P. Lith.

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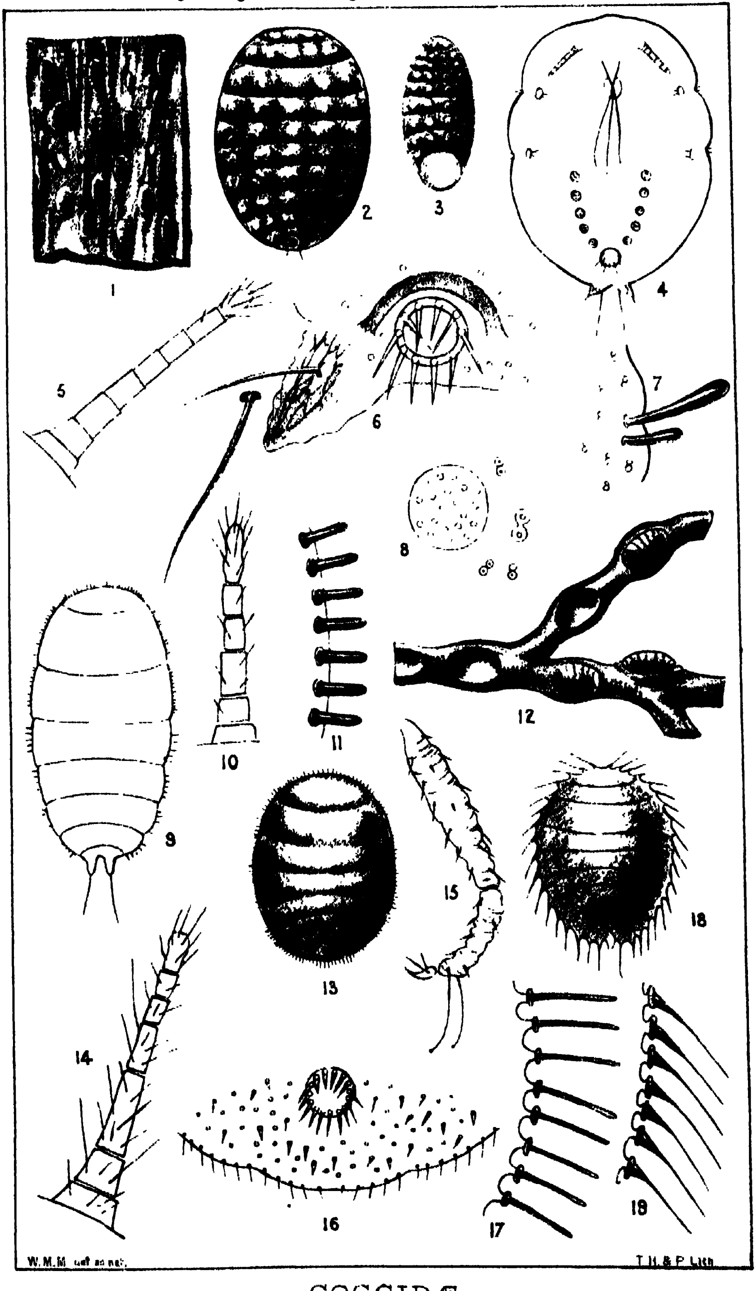


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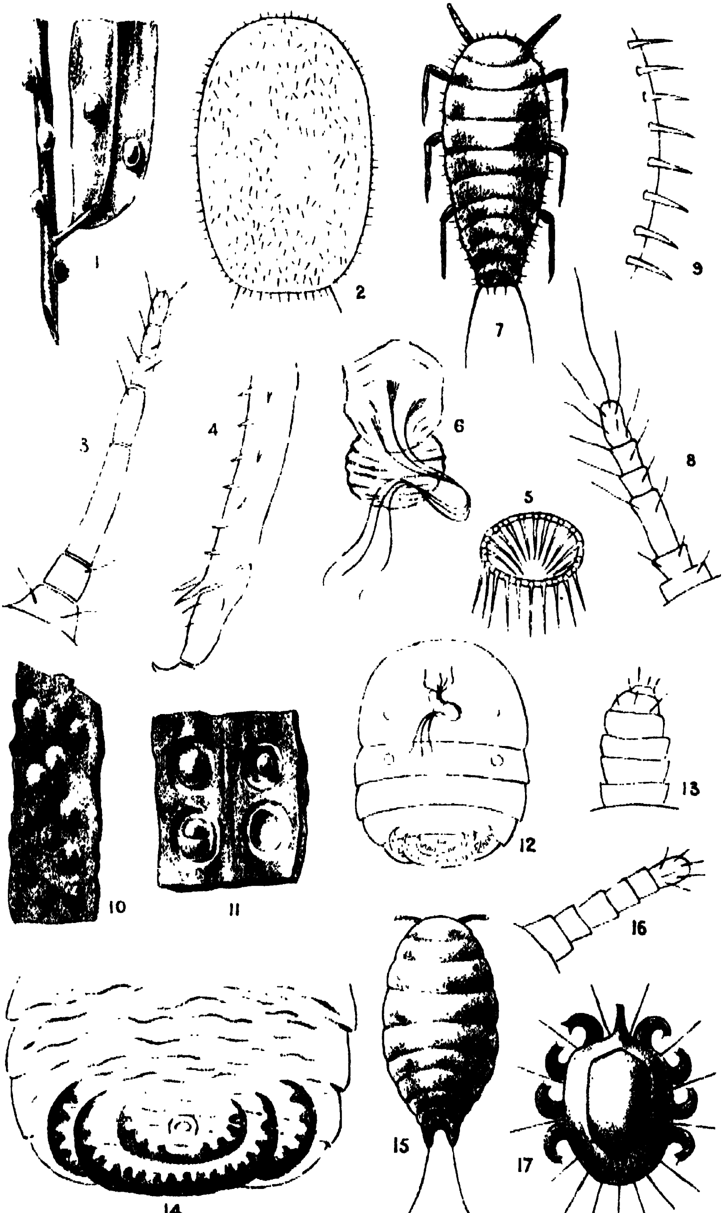


W M M del ad nat

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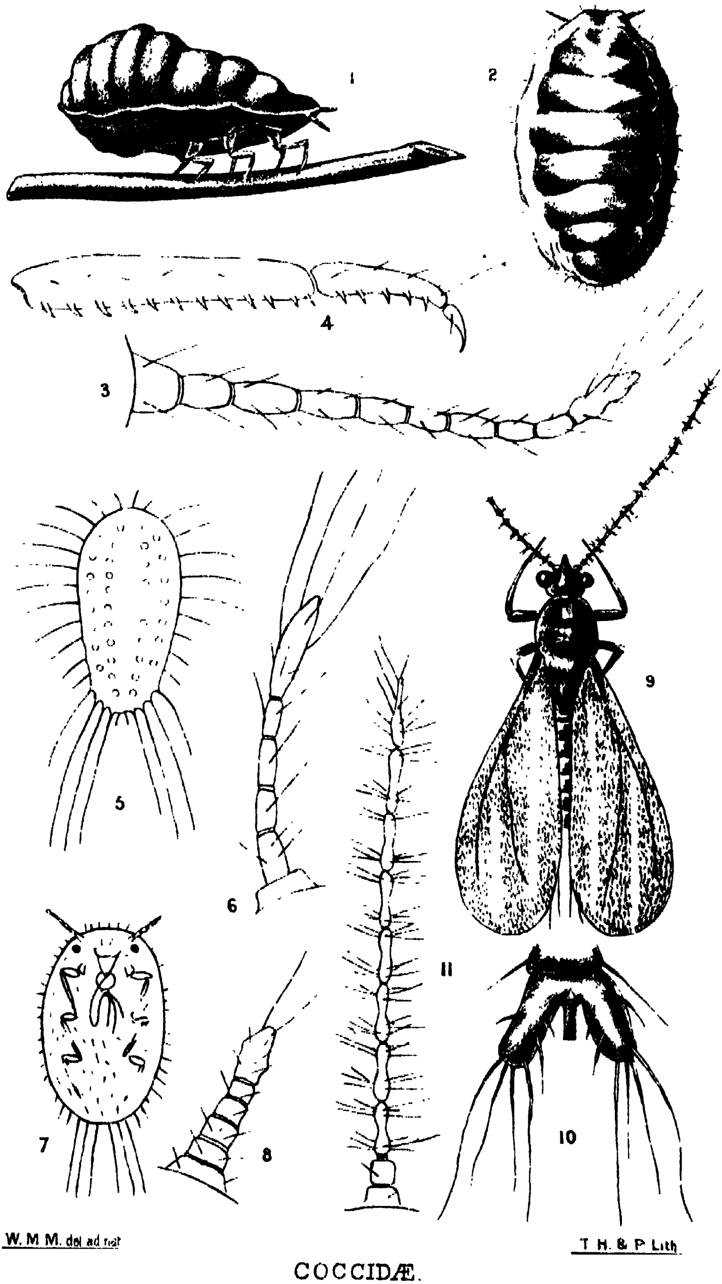


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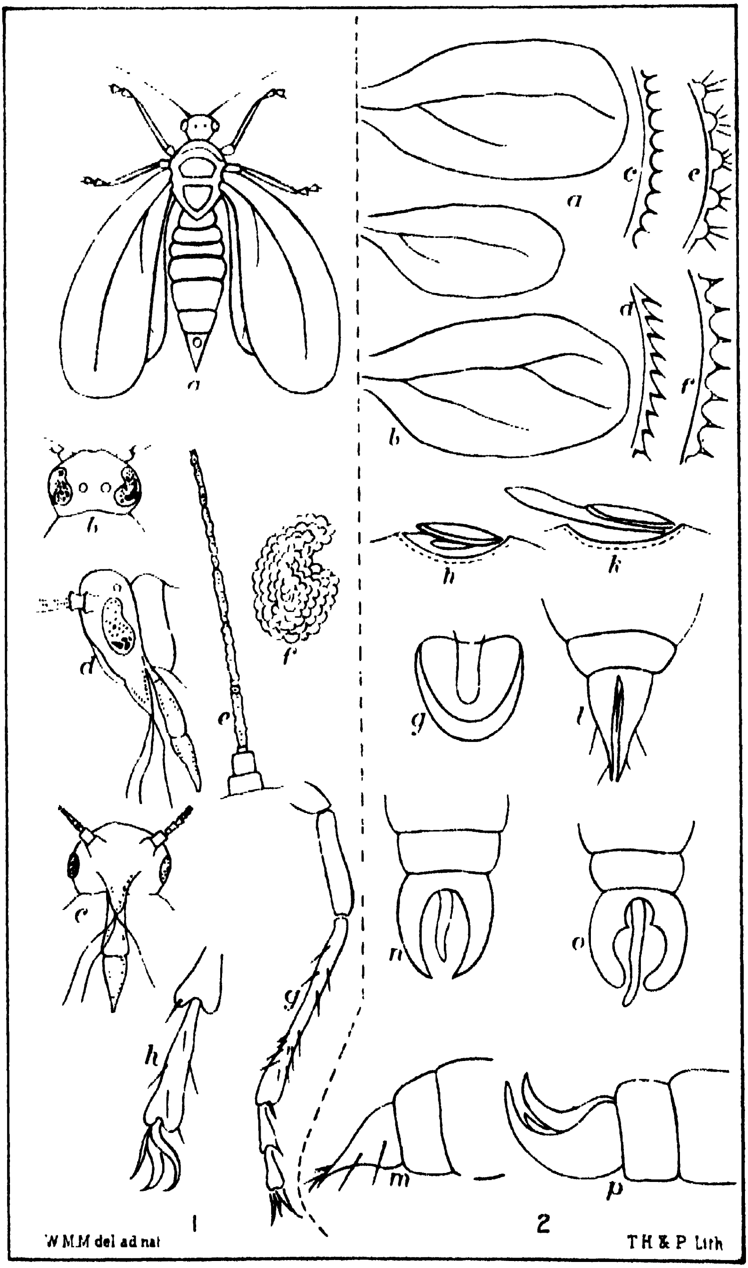


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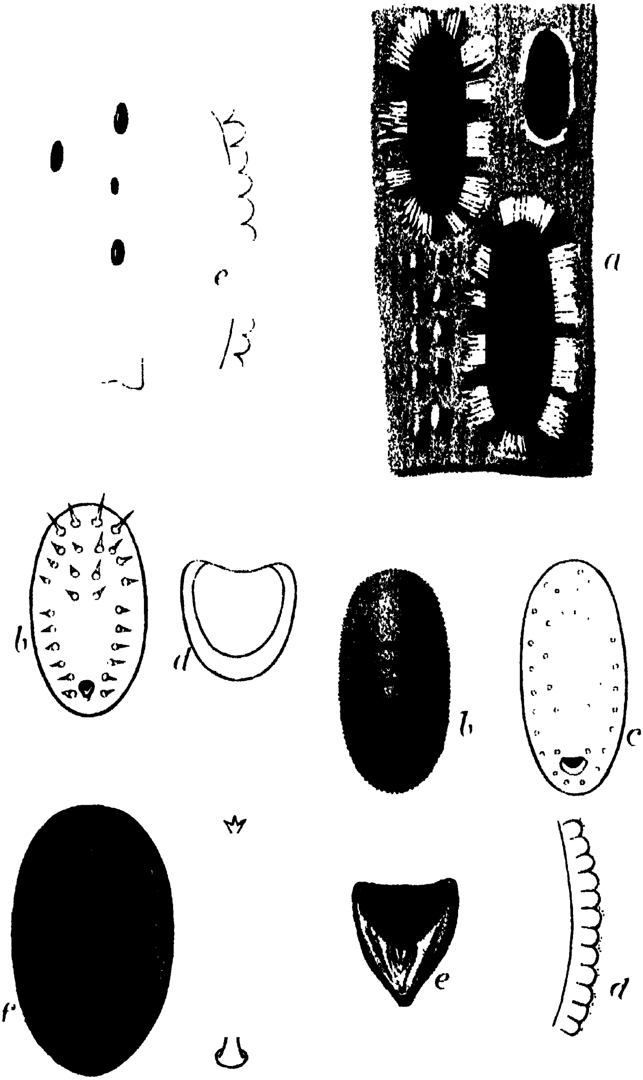


W.M.M del ad nat

TH. & P Lith

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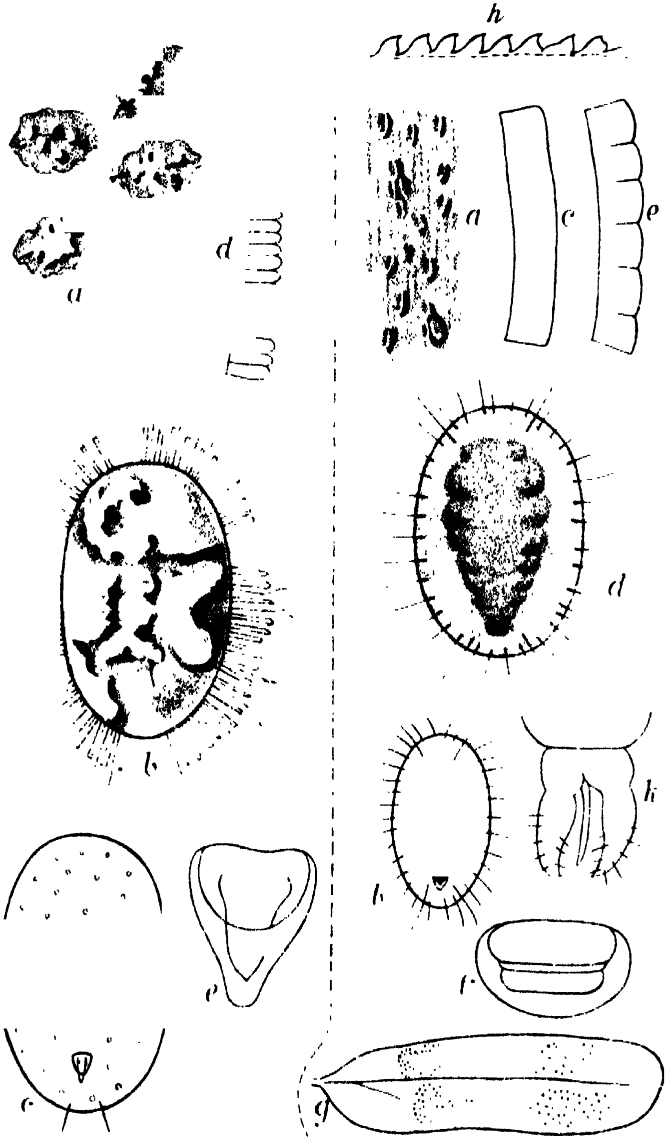


W M M del ad nat

T H & F Lith

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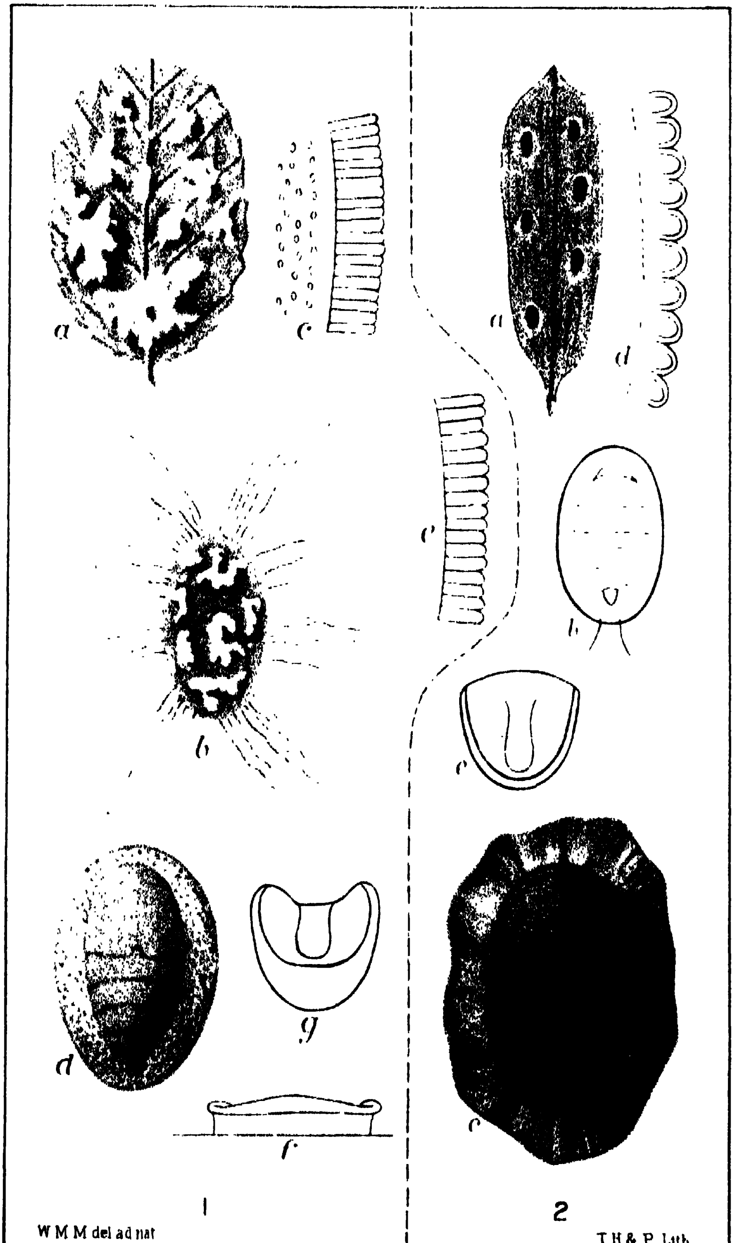


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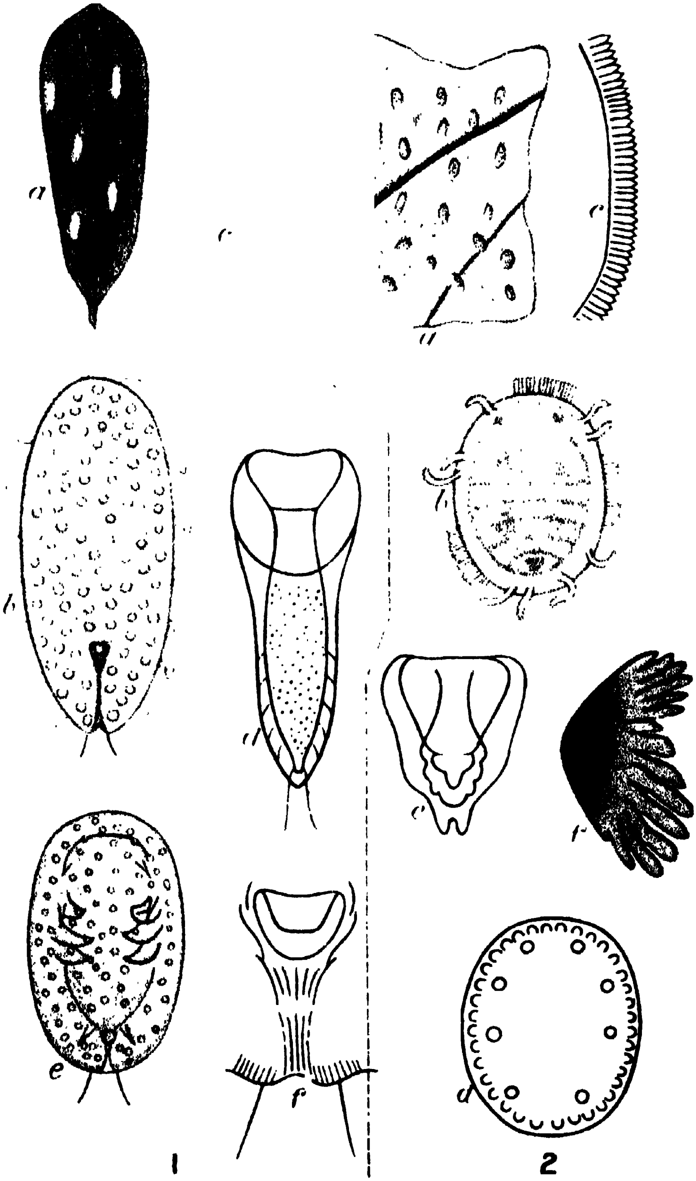


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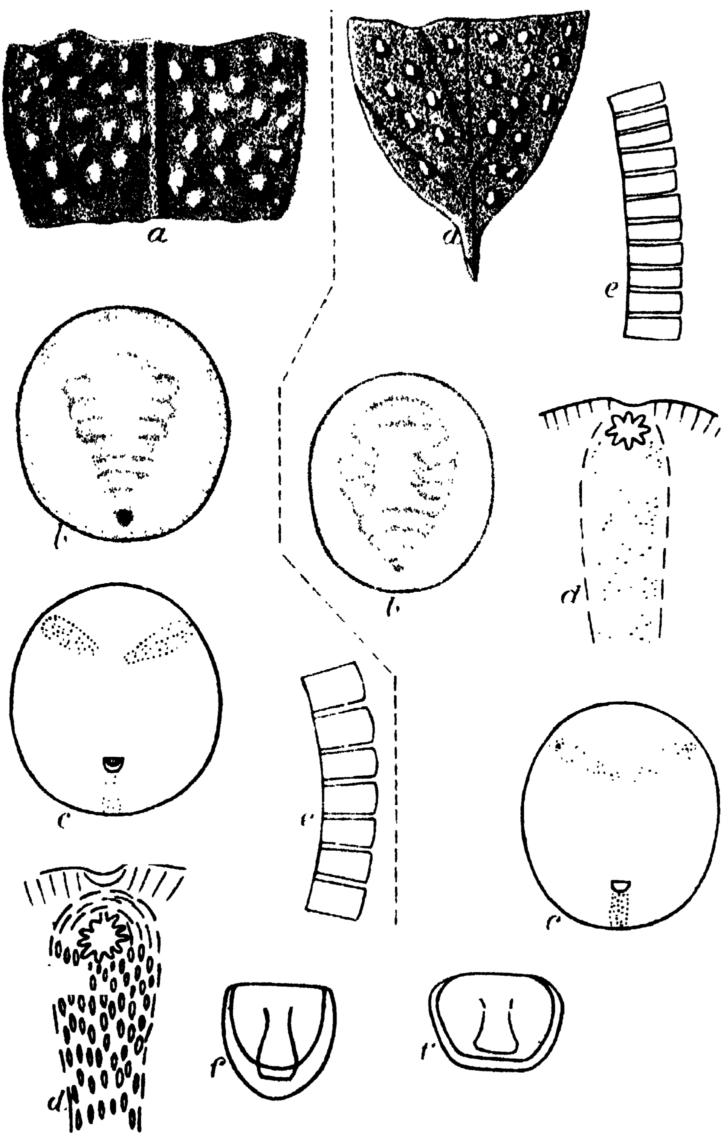


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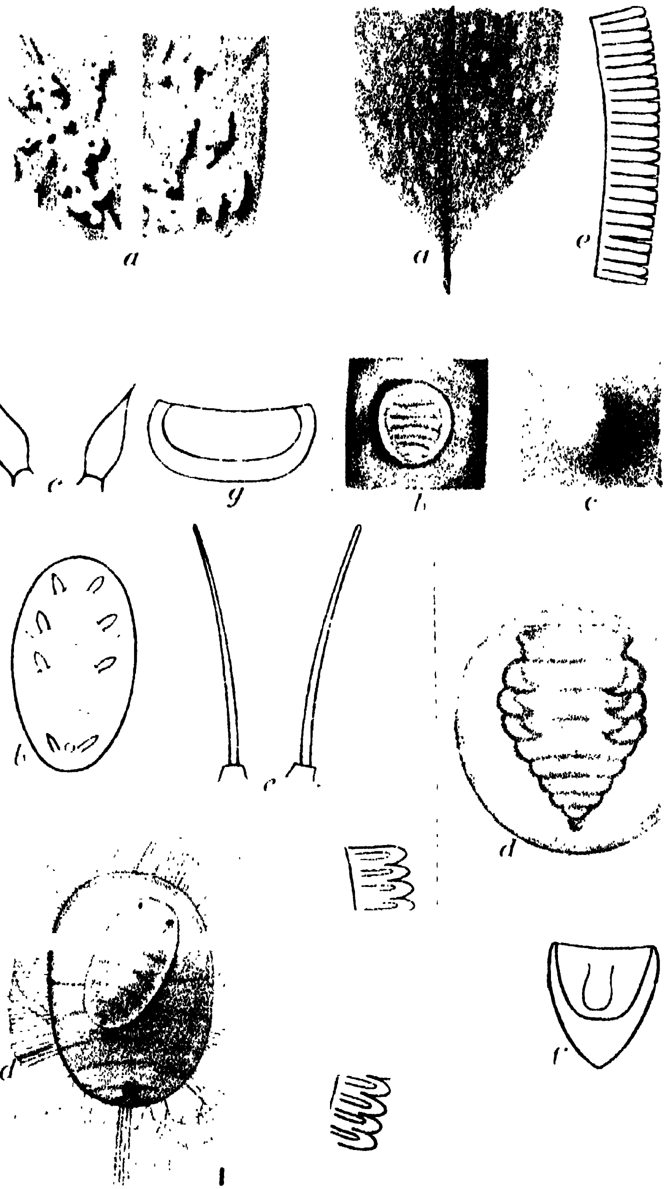

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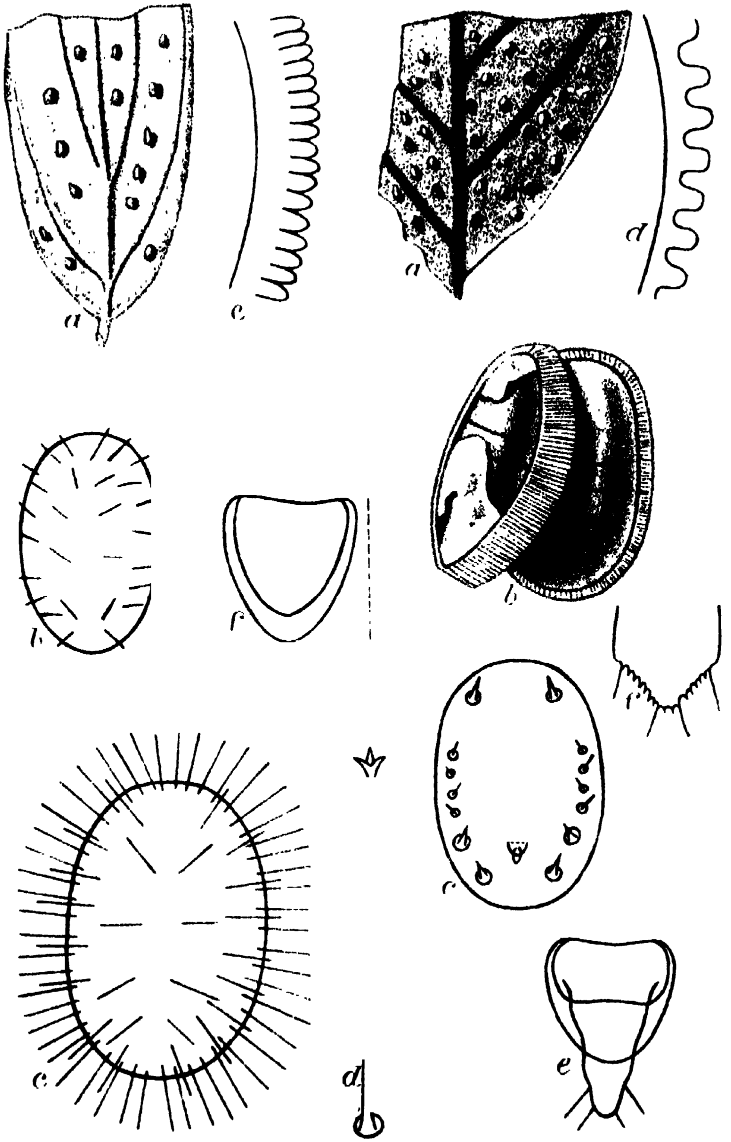

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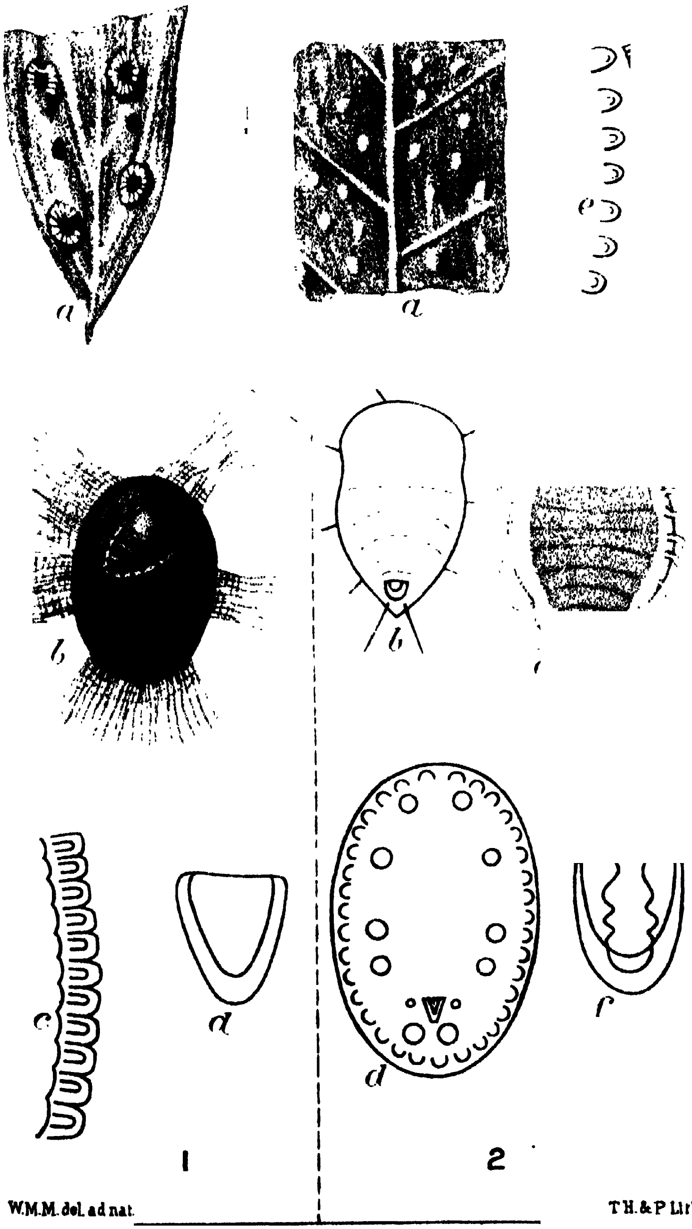


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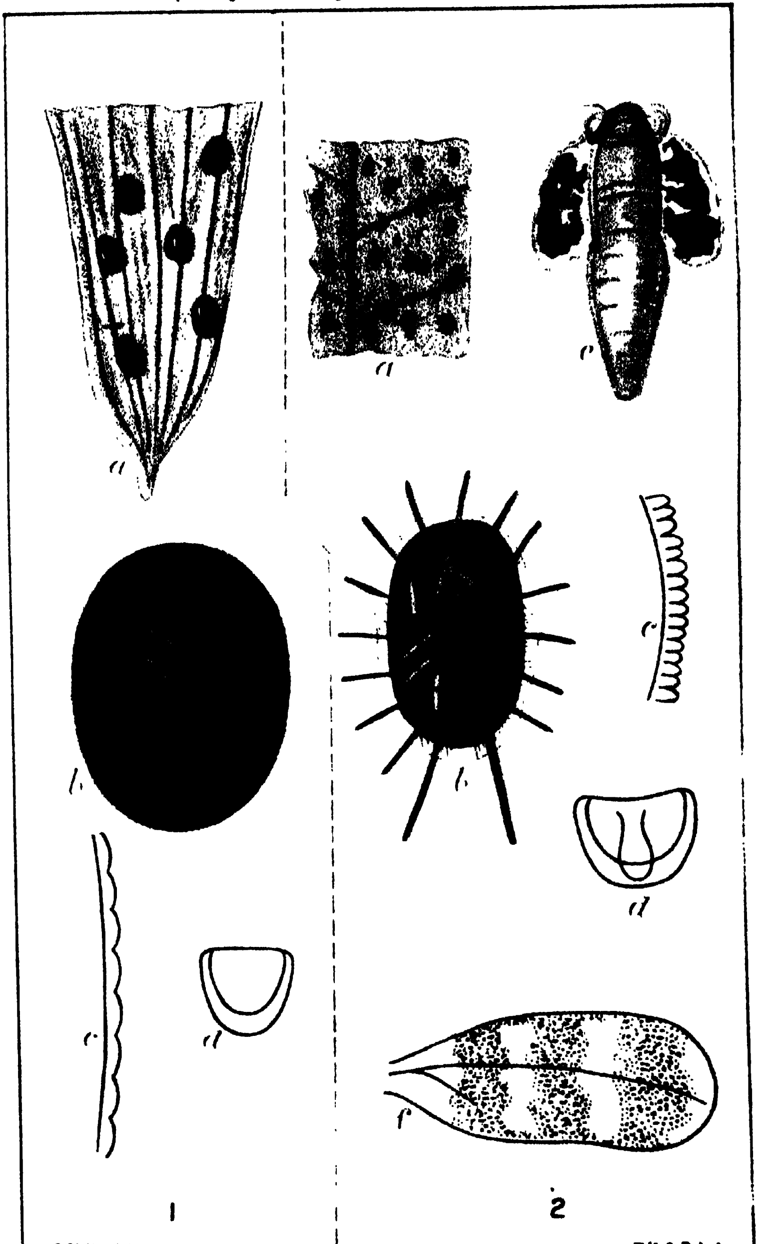


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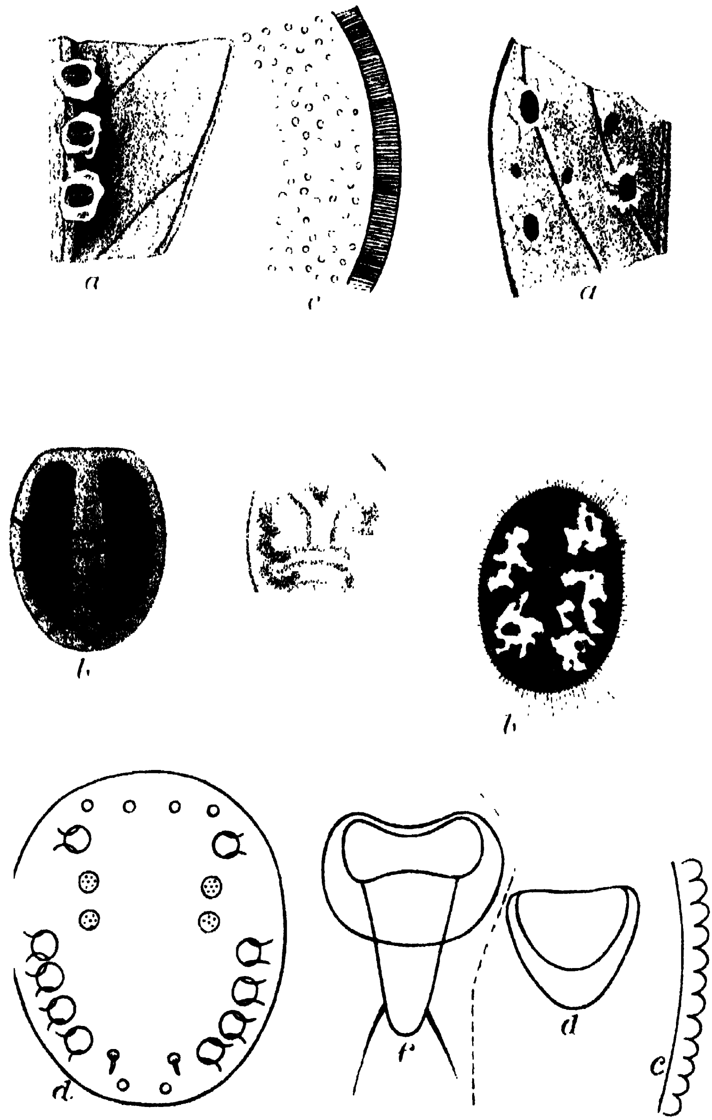

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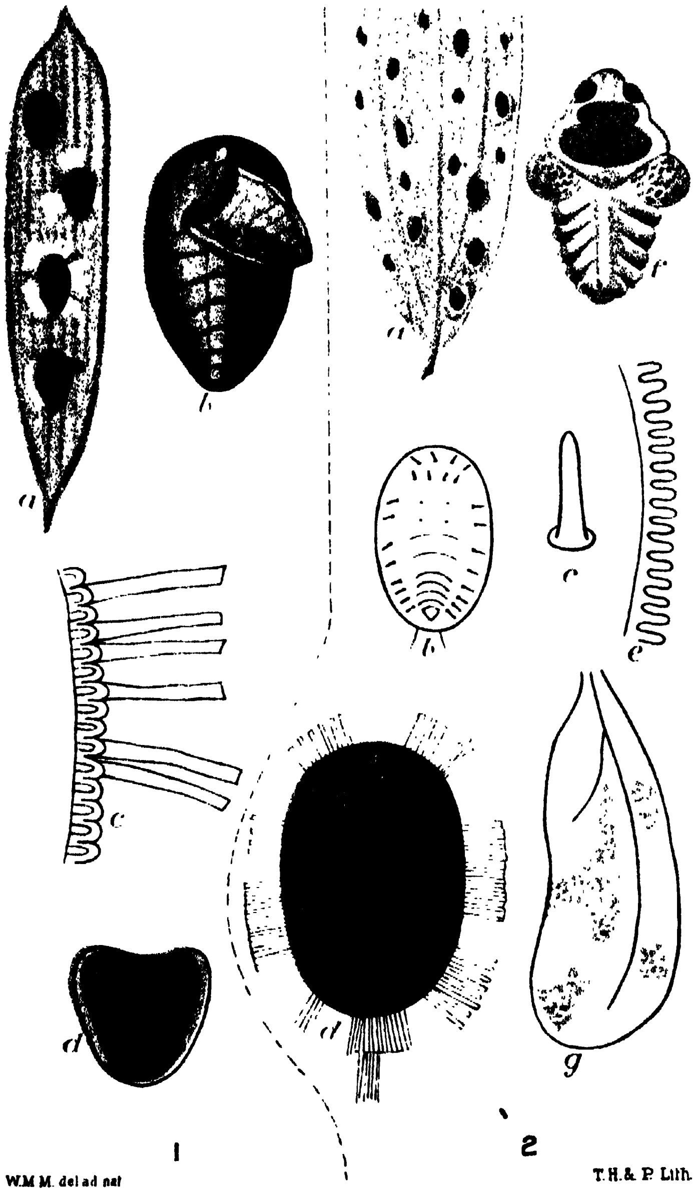


W.M.M. del ad nat

T.H.& P. Lith.

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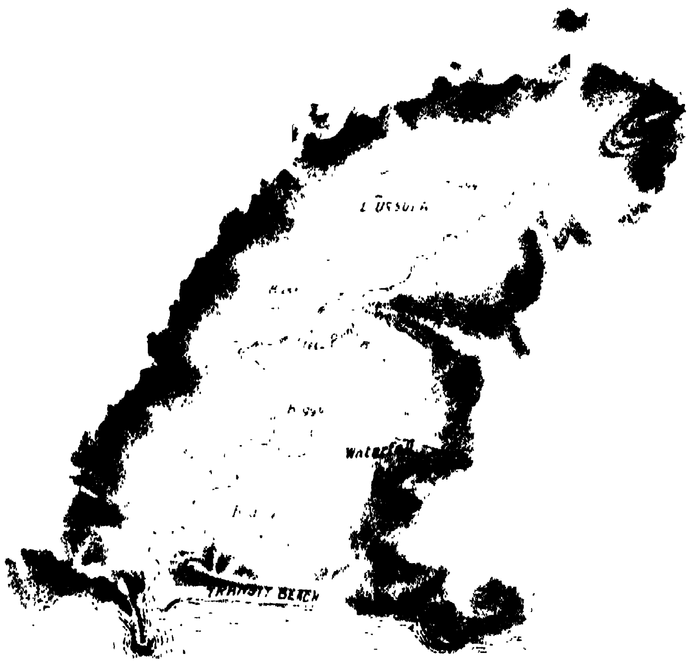
EXCAVATION OF MOA BONES IN PROGRESS. WAIMATE.

*To illustrate Paper by Capt. Hutton, F.R.S.*

NEW RIVER OF MILFORD SOUND

DISCOVERED BY D SUTHERLAND




Scale